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Sky and TELESCOPE

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The Editors Note . . .

IN ITS ISSUE for the third quarter of 1946, just received, the **Journal of Calendar Reform** carries a full account of the non-partisan legislation introduced in the 79th Congress of the United States for the adoption of the World calendar. The opportunity is ripe for the United States to lead the way among the larger countries of the world; already 14 nations have approved the World calendar. The present proposals call for the use of the new calendar to start on January 1, 1950. If you support this 12-month calendar of four identical quarters, write the World Calendar Association, 630 Fifth Avenue, New York 20, N. Y., and then write your senator and congressman.

Scientific Monthly for November celebrates the centennial of the Smithsonian Institution with articles by 11 members of the Smithsonian staff. A separate account of the first 100 years of an institution which has lived up to its donor's dream of spreading culture and knowledge to mankind has been written and published in a 64-page booklet, which may presumably be obtained by writing the Smithsonian Institution, Washington, D. C.

This same issue of the **Scientific Monthly** contains an article by Dr. Bart J. Bok, of Harvard College Observatory, describing the growth and establishment of UNESCO, the United Nations Educational, Scientific, and Cultural Organization. "Construction of the defenses of peace" in the minds of men is the primary aim of the new organization, and it is expected that scientists and science will help in achieving this goal.

Headquarters for UNESCO are in Paris, where in November began the first full conference of the representatives of the member nations, although UNESCO has still to become an integral part of the United Nations. Dr. Bok suggests that every scientist "think hard about UNESCO and its function in the international order."

VOL. VI, NO. 2
Whole Number 62

DECEMBER, 1946

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BACK COVER: Forty meteors recorded themselves on the negative of this 12-minute exposure, taken by Kenneth Spain at Nashville, Tenn., at the time of maximum of the Giacobinid shower on October 9th. The radiant, in Draco, is just off the upper edge of the photograph. The bright stars of the Northern Cross are near the center and Vega appears at the right. The double star Epsilon Lyrae is clearly separated. (See page 14.)

SKY AND TELESCOPE is published monthly by Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass. Entered as second class matter, April 28, 1939, at the Post Office, Boston, Mass., under Act of March 3, 1879; accepted for mailing at the special rate of postage provided in Paragraph 4, Section 538, Postal Laws and Regulations.

Subscriptions: $3.00 per year in the United States and possessions, and to members of the armed services; Canada and all countries in the Pan-American Postal Union, $3.50; all other foreign countries, $4.00. Make checks and money orders payable to Sky Publishing Corporation. Send notice of change of address two weeks in advance. Circulation manager: Betty G. Dodd.

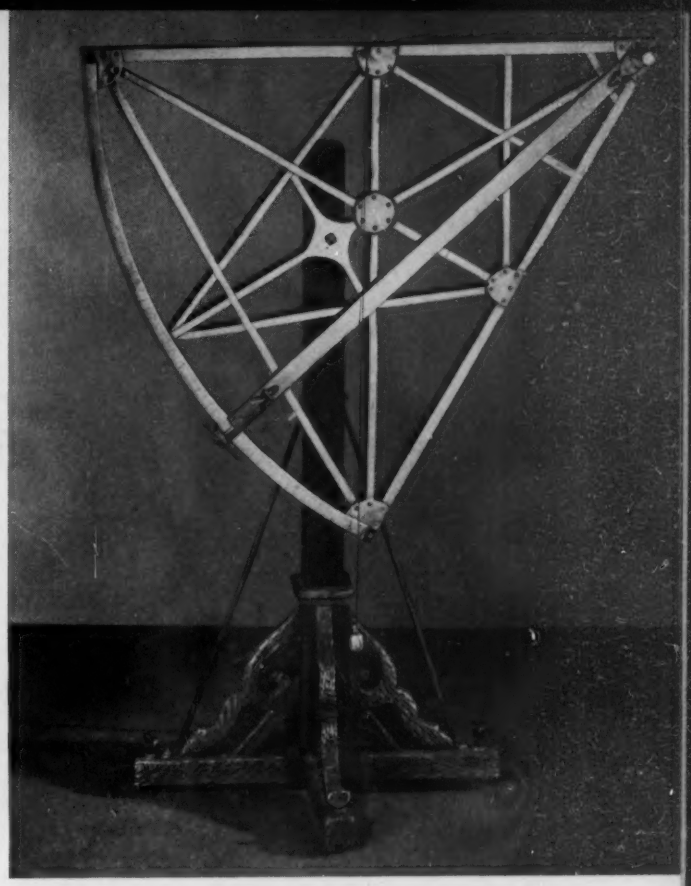
Editorial and general offices: Harvard College Observatory, Cambridge 38, Mass. Unsolicited articles and pictures are welcome, but we cannot guarantee prompt editorial attention, nor are we responsible for the return of unsolicited manuscripts unless return postage is provided by the author.

Advertising director: Fred B. Trimm, 19 East 48th Street, New York 17, N. Y.; ELdorado 5-5750.

The Astronomy of Tycho Brahe

By C. M. Huffer

Washburn Observatory, University of Wisconsin



This model of Tycho's astronomical sextant for taking altitudes was made by L. C. Eichner, of Bloomfield, N. J., one of six such models now on display in Denmark and later to be displayed in England and probably in Russia.

Tycho, who states he invented and named this form of "astronomic sextant," points out that the number of braces is purposely kept small in order to make the instrument portable. In use, the top arm remains horizontal. American Museum photograph.

TYCHO BRAHE — the 400th anniversary of whose birth we are celebrating this year — was the last of the great astronomers who lived and worked before the invention of the telescope. His birth on December 14, 1546, followed by only three years the death of Copernicus, and his death in 1601 preceded by eight years the astronomical use of the telescope by Galileo.

Tycho was only 12 years old when he was sent to the university at Copenhagen to study to be a statesman. This career was chosen by his uncle, who had raised Tycho from early childhood, probably with the consent of his father. Such a choice was to be expected for a boy who belonged to the nobility of the Denmark of that time.

The next year, 1560, there was a small partial eclipse of the sun at Copenhagen which probably started the intended statesman on a scientific career instead. He was already somewhat interested in astrology and considered the eclipse in its astrological implications. But the study of astronomy was forbidden by his uncle and had to be done secretly. Apparently Uncle Jörgen found out about it, because two years later he sent his nephew to Germany to study in Leipzig, hoping that he would abandon his study of astronomy.

For a companion and tutor to the young man; Jörgen Brahe chose a student of divinity and history named Anders Vedel, who was only four years older than Tycho. This tutor, however, failed to keep his pupil on the road to a public career, and gradually came to the conclusion that Tycho was destined for a career in science. During the three or four years of this tutor-student relationship, young Tycho had concealed a star globe and planetary tables, and had studied astronomy, learning the constellations while Vedel was asleep. In spite of strained relations at times, the two actually became good friends and their friendship lasted for about 40 years.

After leaving Leipzig, Tycho's education was continued in Wittenberg and soon after in Rostock, Germany. At Rostock there were several men connected with the university who were interested in astrology and alchemy and the relationship of these so-called sciences to mathematics and medicine. They seem to have been seriously attempting to supplement their meager knowledge of medicine by investigating the relation between the heavenly bodies and the human body. Since the light and heat of the sun were definitely beneficial for plant and animal life, it was thought that the moon and planets should have some effect also. This correlation should have been tried at some time in the history of science, and these men ought not to be criticized because they attempted to establish it. The 16th century was the last in which astrology and alchemy were seriously considered as sciences.

The first observations made by Tycho were of a conjunction of Jupiter and Saturn in 1563, when he was 16 years old. His first instrument was a pair of compasses. He sighted along the two legs of the compasses at a planet and at a nearby star or, as in this first observation, at the two planets, and later measured the angle on a divided circle. Thus, he found the time at which the two planets were nearest together — a date which was in disagreement with the two popular tables in use at that time. This error in the tables helped the young astronomer to decide that accurate observations were very desirable, a decision which he spent the rest of his life in carrving out.

The next year he replaced the compasses with a cross-staff, which consisted of a rod about three feet long and another cross rod which could be made to slide along the first. By sighting along a fixed sight on the longitudinal rod and a moving sight on the cross rod, the angle between the two stars could be read off directly by means of a scale. In spite of careful work in graduating the scale, he found that there were errors in the angles and so had to devise a table of corrections. This difficulty was also one to which he devoted the rest of his life — the attempt to make the best observations possible.

Tycho began serious work in astronomy in 1569 and 1570 while living in Augsburg, Germany. The intervening years had been spent in study and travel in various parts of Europe, and he had apparently built several small instruments in his attempts to make accurate observations. In Augsburg he was associated with two brothers, one of whom, Paul Hainzel, agreed to pay the cost of construction of a large quadrant, since Tycho thought a large instrument would give more accurate angles. So with the help of skilled workers, the quadrant, with a radius of about 19 feet, was built and erected in Hainzel's garden.

Since the quadrant and the sextant were the principal instruments used during the lifetime of Tycho, a short description of each should be in order.

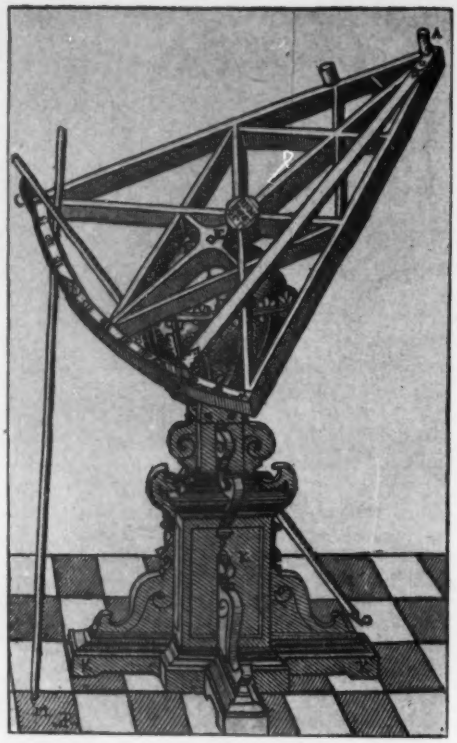
One of the two forms of the sextant as used by Tycho had a fixed horizontal arm to which was attached a circular arc, as shown in the Eichner model pictured above. This arm was oriented by means of a plumb line attached to its center. One end was the center of the graduated arc. Another arm was movable about the center and its position was read off a graduated scale with diagonals as in the mural quadrant. The observer sighted along the movable arm and the reading indicated the angle between the line of sight and the horizontal. This instrument was mounted on a stand which could be turned in any direction, for example into the plane of the vertical circle through the star.

The other form of sextant required simultaneous observations by two observers. The arm to which the graduated scale was fixed was not held horizontally, but was oriented toward one star by one observer. The other, the movable arm, was pointed toward the other star by the other observer. The angle read off the scale then gave the angle between the two stars. If the two objects were so close together that the heads of the observers would be in the way of each other, there was a sight parallel to the fixed arm by which the fixed arm was oriented. The movable arm was used in the usual way. This form of the sextant was also mounted on a movable stand. There were three sextants in Tycho's observatory at Hveen. One was made entirely of brass. Another was of wood with a brass arc of radius 5½ feet. Although these sextants were considerably smaller than the large mural quadrants, Tycho apparently preferred them because of their flexibility.

The usual form of the quadrant was the mural quadrant. In this instrument, there was a sight which slid along the arc of a circle graduated to read degrees and fractions of a degree. The center of the circle was located in a hole in the wall through which the observer saw the star whose position was to be measured. While looking through the sight, which was directed to the hole and therefore towards the star, the angle of the star with the vertical or the horizontal direction was measured by reading the position of the sight on the graduated arc.

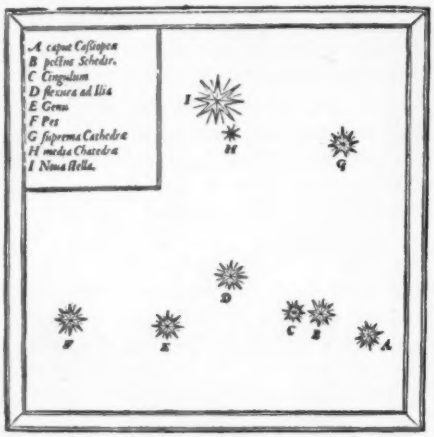
The arc was accurately marked off into degrees, and the degree marks were connected by diagonal lines. By reading off or estimating the fraction of a diagonal line where the sliding sight intersected the scale, it was possible to read to the nearest fraction of the degree which measured the altitude of the star. This device has usually been credited to Tycho himself, although he said he got the idea from a professor of mathematics at Leipzig. He later used a series of dots instead of lines. The error of an observation was reduced to about 1/1,000 of a degree, thus accounting for the remarkable reliability of his observations.

One great objection to the mural quadrant is that it limits observations to a single direction, usually the meridian or a direction at right angles to the meridian (the prime vertical). The Augsburg instrument, however, was suspended at the center and could be rotated around a vertical axis, two sights being fixed along a movable radius. The altitude of the star was then measured by reading the angle between the radius and a plumb line. It is not certain that Tycho actually used this quadrant, but it stood on its original site until destroyed in a storm in 1574.



This form of Tycho's sextant is designed for use by two observers. Reproduced from "The Great Astronomers," by Robert S. Ball.

During Tycho's period of residence in Augsburg, he started construction of a celestial globe five feet in diameter. On this globe he planned to plot accurately the positions of the stars as he observed them. The globe was made of wooden plates strengthened by inside rings. It was later covered with brass plates on which the stars and the equator and hour circles were marked. It was not finished when Tycho left Augsburg, but was completed under Hainzel's direction and moved to Tycho's observatory where it was kept and used in the library of his house.



From Tycho's book, "De Nova Stella," we reproduce a diagram of the constellation of Cassiopeia, showing the place of the nova marked close to the star which is now called Kappa. Many libraries have the 15-volume "Opera Omnia" of Tycho Brahe, edited by Dreyer and published in 1913, in which are reproduced such diagrams as this and the one of the lunar eclipse opposite.

In 1570 Tycho returned to Denmark and gave the next two years of his life to the study of chemistry, with astronomy apparently neglected. Again it must be remembered that since there was supposed to be a correlation between the planets and certain metals — Mercury and quicksilver, Venus and silver, the sun and gold, Mars and iron, Jupiter and gold or tin, and Saturn and lead — it was to be expected that an astronomer should give attention to chemistry. But the lack of evidence of the supposed relationship certainly led Tycho to abandon his chemical experiments and to give his entire time to the improvement of astronomical observations. This decision was hastened by a very unusual occurrence, the appearance of a new star.

On the evening of November 11, 1572, Tycho was startled by the appearance of a star in Cassiopeia where he knew none existed before. Not believing his own eyes, he asked his servants and some peasants if they saw the same thing. When assured that they saw the star also, Tycho began systematic measures of its position with a new sextant he had just built. His observations showed no parallax (erroneously reported in Germany to be three or four degrees) and placed the nova among the stars. (The star had probably been seen by other observers between the 2nd and 6th of November.)

According to the Ptolemaic theory, still accepted by most people in 1572, there should be no changes in the "eighth sphere" where the stars were supposed to be. The mystery of the appearance of the new star was greatly increased by the succeeding changes not only of brightness, but also in color. On November 11th, it was as bright as Venus and could be seen in the middle of the day. Then it faded slowly, and ceased to be visible in the spring of 1574, 16 months after its discovery. The color was at first white, changing to yellow and reddish; then the star became about the color of Saturn until it disappeared. Tycho, in his book about the nova, said that it was no more unusual for a star to change color than for it to appear and disappear. All of this, of course, was in complete disagreement with the then popular theory of the nature of the universe.

When Tycho was 27 years old, he moved with his wife and increasing family to Copenhagen, where the university requested him to give a course of lectures on astronomy. His fame as an astronomer was rising, and since there were no lectures on astronomy being given at the university at that time, it was only natural that Tycho should be approached. He at first refused; but when the king also asked him to consent, he yielded and began the series on September 23, 1574, with an oration on astrology. J. L. E.

Dreyer, in his book *Tycho Brahe* (published in 1890), gives an abstract of its contents. The oration, "De Disciplinis Mathematicis," was published in 1913 in Volume I of *Opera Omnia* of Tycho Brahe, edited by Dreyer.

The opening paragraphs of the oration have been reconstructed and are presented here as though Tycho were addressing a modern audience:

Science of ancient times was divided by some philosophers into four distinct classes. There were: first, arithmetic (numbers absolute); second, music (numbers applied); third, geometry (magnitudes at rest); and fourth, astronomy (magnitudes in motion). Of these the science of geometry, measurement, has a higher purpose than merely measuring land, and the divine Plato turned away from his teaching all those who were ignorant of geometry, as being unfit to devote themselves to other branches of philosophy. The high degree of learning reached by the ancient philosophers was due to the fact that they were imbued with geometry from their childhood, while we, unfortunately, have to spend the best years of our youth on the study of languages and grammar, which those ancient philosophers acquired in infancy without trouble.

Astronomy is a very ancient science. According to Josephus, it can be traced back to the time of Seth, while Abraham from the motions of the sun, moon, and stars perceived that there was but one God, by whose will all was governed. It was next studied by the Egyptians, the Babylonians, the Hindus, and the Chinese. We owe our knowledge above all to Hipparchus, Ptolemy, and more recently to Nicolaus Copernicus, who, not without reason, has been called a second Ptolemy. He, having by his own observations found both the Ptolemean and the Alphonsine theories insufficient to explain the celestial motions, by a new hypothesis deduced by the admirable skill of his genius, restored the science to such an extent that he had a more accurate knowledge of the motions of the stars than anybody before his time. And though his theory was somewhat contrary to physical principles, it admitted nothing contrary to mathematical axioms, such as the ancients did. They assumed the planets to move in epicycles and eccentrics, the motions being therefore irregular with respect to the centers of these circles. This is absurd.

A great many astronomers of the present time as well as of the past have gone into raptures about the beauties of a sunset or of a moonrise or of the conjunction of planets. It is obvious, however, that such casual observations will do nothing to assist in a determination of the variation of the moon's distance from us, or of the revolutions of the planets; nor will they assist in a prediction of coming eclipses and other astronomical phenomena which can be predicted in advance.

The utility of astronomy is easy to perceive, as no nation could exist without means of properly dividing and fixing time, while the science itself raises the human mind from earthly and trivial things to heavenly ones. A special use of astronomy is that it enables us to draw conclusions about human fate from the movements in the celestial regions.

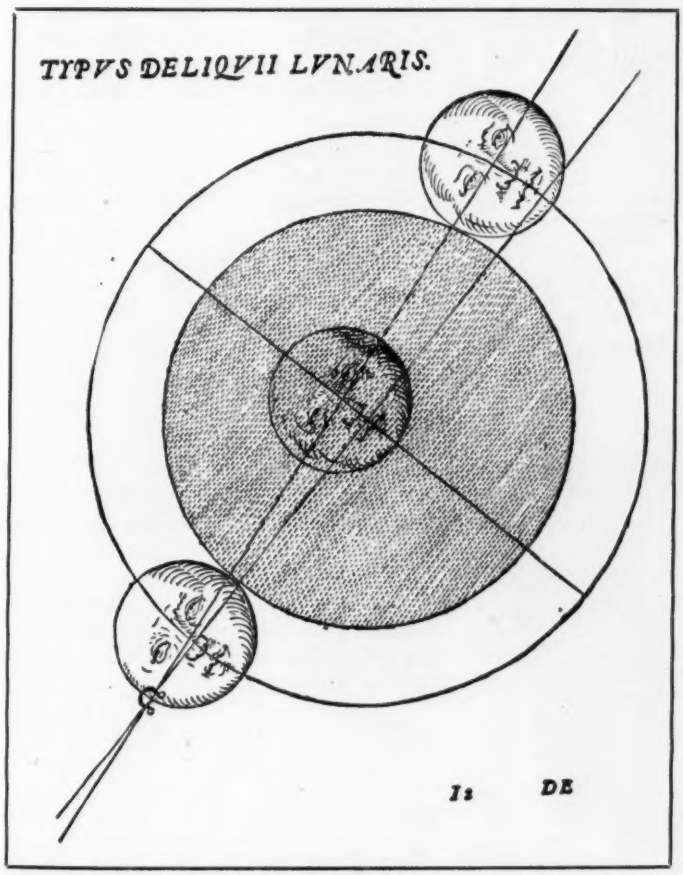
He then went on to give the accepted theories of the influence of the planets on human affairs and in particular on the functions of the human body, but apparently his faith in astrology was not great, because he concluded in the following words:

These foregoing astrological ideas are in accordance with those of contemporary writers, but I should like to point out that I do not consider the fate of man to be absolutely settled by the aspect of the stars; but that God could alter it if He wills; nor is man altogether bound by the influence of the stars; but God has made him that he might conquer that influence, as there is something in man superior to it. The objection to astrology, that it is a useless art since knowledge of the future is undesirable, would only hold good if it were impossible to resist the influence of the stars; but being forewarned, we might try to avert the threatening evils and find that in this way astrology is of the greatest value.

Sir David Brewster in his book, *Martyrs of Science,* says: "Tycho seems to have entirely renounced his astrological faith in his latter days; and Kepler states that Tycho carried on his astrological labors with his mind entirely free from the superstitions of astrology; that he derided and detested the vanity and knavery of astrologers, and was convinced that the stars exercised no influence on the destinies of man."

(Concluded next month)

L. C. Eichner's model of Tycho's steel sextant for measuring distances by a single observer. With convenient screws the entire instrument could be taken apart and "packed in a chest when necessary and carried to distant parts . . . . It was of immense value in the observations of the comet of 1577." The quotes are from Tycho's writings.



Among the many interesting charts and diagrams in Tycho's book, "De Nova Stella," is this one showing the circumstances of a total eclipse of the moon in December, 1573.

A Christmas Fantasy

By Robert R. Coles, *Hayden Planetarium*

ARTICLES explaining the various theories regarding the identity of the star that the Magi followed to Bethlehem have appeared in the December issues of *Sky and Telescope* magazine for some years. The content of these stories has been the theme for the Christmas lectures that have now become traditional in many planetariums throughout the country. This story of the Christmas star, as revealed under the man-made skies of a projection planetarium, always attracts great attention, and there are many who return year after year to make it a part of their regular holiday celebration.

Certainly there is no season of the year more appropriate for us to consider the stars. When we think of the tremendous size of the stellar universe with its scintillating jewels of light, we cannot help but experience something of the majesty that pervades all creation. A star-filled sky above a snow-frosted landscape provides the ideal setting for a Christmas story. There is some mysterious quality in these remote worlds that provides the perfect bridge connecting modern man with ages gone by. As Emerson so aptly expressed it in his essay, "Nature":

"The rays that come from those heavenly worlds will separate between him and what he touches. One might think the atmosphere was made transparent with this design, to give man, in the heavenly bodies, the perpetual presence of the sublime."

Children are in the majority among those who come to the Hayden Planetarium at Christmas time. This is to be expected, of course, as Christmas is very much a holiday for young people. And the story of Santa Claus, the symbol of the Christmas tree, and the offering of gifts have a unique appeal to those of youthful spirit, regardless of their years. In addition to its religious aspect, Christmas is a time for joyous music and story telling. It provides an almost boundless range for the play of the imagination in weaving together the most interesting tales.

It is in this spirit that we now invite you to join us on a special Christmas excursion into the realm of fantasy.

The time is Christmas eve. The place can be anywhere beneath the sparkling stars. We are about to begin one of the most usual tasks you can imagine — that of decorating a Christmas tree. But this is no ordinary tree. It is a huge celestial Christmas tree whose tapering summit reaches into the rich blue depths of the night sky. And the decorations will not be those of perishable tinsel and glass that can be purchased here on earth. This tree will be adorned with ornaments that are in harmony with its magnificent stature—with stars, planets, and other rare gems plucked from the tapestry of the heavens.

First we will scatter a few thousand "average" stars on the boughs, just to provide an appropriate setting for the more spectacular ornaments that are to be added.

To add a touch of color we might place the blue-white star, Sirius, on one of the lower branches where its rays will penetrate in all directions. And nearby, for contrast, we shall hang the red giant Antares, fresh from the heart of the Scorpion. Not far from these the yellow star, Capella, will shine conspicuously. Then, irregularly scattered throughout the branches, will be such brilliant ornaments as Altair, Vega, Arcturus, Aldebaran, Betelgeuse, and Spica. This company of celestial sparklers will give our Christmas tree a touch of living splendor such as no tree before has ever known.

Mingled among these stars will be several score of eclipsing binaries and Cepheid variables whose alternate blinking will create an elusive effect of incomparable beauty. And to further enhance our tree we shall entwine the pearly band of the Milky Way, like angel's hair, in and about its green boughs. Then, in keeping with the occasion, we shall place a few of the more striking

Drawing by Walter Favreau

constellation figures on the branches, with others grouped beneath them like toys. The Big and Little Bears will adorn a prominent niche, as will the Swan, the Eagle, and the Winged Horse.

But these decorations are of minor significance compared with the one to be mounted on the summit of our celestial Christmas tree. For that place we shall select the one symbol from the heavens that really belongs to Christmas—the Christmas star. Immediately, however, we encounter some difficulty in making our selection.

Today there is no one who can definitely say what it was that led the Wise Men at the time of that first Christmas. There are many interesting theories, however, covering a wide range of possibilities. And among these is the suggestion that it may have been a supernova that appeared unheralded in the night sky and gradually increased in brilliance until it eventually outshone every star in the heavens. We are told that the Magi were thoroughly familiar with the stars and constellations. Had anything like Tycho's star of 1572 appeared they would surely have recognized it as something most unusual and might well have interpreted it as the sign for which they were looking.

Such a star would provide an ideal ornament for our purpose. Its scintillating beauty would surpass everything else on the tree.

Again, it has been suggested that the sign they followed was not a star at all, but a most unusual configuration of the planets Mars, Jupiter, and Saturn, forming a triangle in the constellation of the Fishes. This occurred in the year 6 B.C., and certainly its appearance must have attracted wide attention and called for something more than a casual explanation. Since it is well established that our present chronology is in error by at least four years, and perhaps more, there is a very good possibility that the Nativity may have been as early as 6 B.C., and this unique arrangement of planets could well have been the beacon that led the Magi to Bethlehem. And while no stretch of the imagination could picture this triangle of planets as a star, it was surely conspicuous and unusual and might have been interpreted as an appropriate symbol. Then, in the telling of the story through the centuries it would, perhaps, be called a star.

With these three planets, ruddy Mars, giant Jupiter, and ringed Saturn, arranged as a triangle and crowning our celestial tree, no more appropriate symbol could be desired.

The theory that a comet appeared at the right time to lead the Wise Men has been suggested. And certainly one of these cosmic vagabonds with its tenuous tail arching into space would provide an interesting spectacle on our tree.

(Continued on page 22)

ASTRONOMICAL ANECDOTES

TYCHO, THE STAR GAZER (1546-1601)

Commemorating the 400th anniversary of the birth of Tycho Brahe

PART II

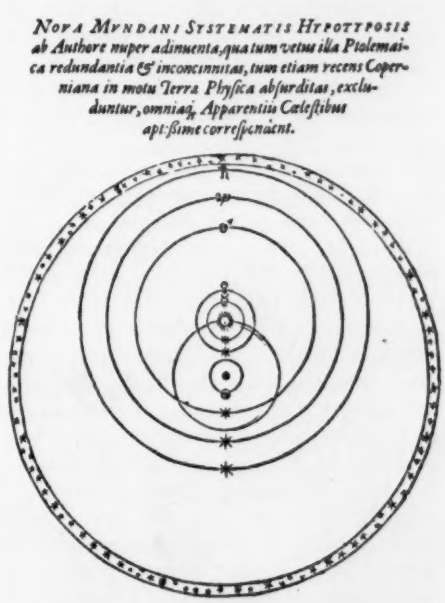
But as the Danish Tycho watched the stars
And plotted planets' paths, and daily took
His exercise in matters alchemists
Of that age deemed full worthy of their arts,
He often brushed aside the humbler things
His peasants brought to him from their poor homes
And fields beyond the walls that set apart
The master's house and all the land that lay
Within his management. So steeped was he
In mysteries of matter and of space,
Affairs of life and death of those who were
The tenants on his land could scarce compel
A moment's thought for their solution. Then
The poor would importune the stewards of
The king for redress of their grievances.
The chapel fell in disrepair, although
It was condition of his holding Hveen
That Tycho Brahe should keep it up and hold
The services for all his tenants and
His retinue. A lighthouse stood on Hveen
To guide the ships that sailed the Sound; its keep
Was in the charge of him who held the isle
And all its benefits, yet Tycho failed
To keep its light agleam across the sea
Except when urged by royal messenger.
But Frederick was tolerant, and saw
That Tycho's tenants did not suffer want;
He dipped into his purse and added thus
To what the isle of Hveen had cost the crown.
But what was gold, when comets came and arcked
Their paths across the sky, while Tycho and
His pupils took the measures of their ways?
Then livelier discussions would go on
Than ever diplomats or envoys held
In treaty-making times. For had not all
The wise ones of the past said comets' tails
Were generated in the upper air,
Beneath the Moon, and not among the stars?
And did not Tycho now, with measure true
And absolute, show parallax to be
For comets quite as small as Jupiter's,
The which he could not measure with his skill?
The comets, then, were off away from Earth,
And roamed beyond the Moon, and not in air
Of this terrestrial ball. True citizens
Of the broad universe they were, and not
Mere exhalations as a cloud of Earth.

And when the company assembled was
To talk of whether Earth were moved, or stayed
Immovable, the center of the wheel
Of all the cosmos, Tycho tried, but could
Not make his mind desert the early thought
That Earth could never move, so sluggish was
Its bulk beneath his feet. Some pupils there
Were so inclined as to believe the work
Copernicus had published as his days
Were drawing to a close, a full three years
Before the birth of Tycho Brahe. But if
The Earth were moved in annual path, its place
From season to the opposite would change
By quite enough to let the parallax
Of stars be shown by Tycho's instruments—
Or so they thought, misled by meager skill
At contemplating true infinity.

But Tycho never quite content could be
With theory that would not plot the place
Of planets true; the wheels on wheels that made
The maze of Ptolemy's hypothesis
Could never serve to calculate the way
A planet truly moved. The Danish mind
Then turned to compromise; a theory
To harmonize the motions that he knew
From endless measurement might be conceived.
Suppose the Earth to be the center of
The motions of the Moon and Sun alone;
Then let the Sun be pivot for the paths
Of all the planets else. Would this new scheme
Accomplish all Copernicus had hoped
From his revival of old Greek beliefs?

Among the guests who stayed awhile at Hveen
Was Reymers Baer, called Ursus, who engaged
In lively talk about the matter when
It first was broached. In later years, the scheme
Appeared beneath the name of Reymers Baer,
And Tycho swore that thief had never lived
So base as Ursus, who had filched a scheme
For running all creation, while a guest
At Hveen. But time was ripe for theories,
And likely is it then that both the Dane
And Reymers Baer original had been
In dreaming up this plan to organize
The better rolling of the heav'nly spheres.
A point to mark in all this bickering
Is that in Tycho's scheme the Earth was fixed
As firm as Ptol'my's plan had made it fixed:
In Baer's design, the Earth was turned each day
By motion in itself, to obviate
The daily whirling of the whole domain
Of stars and planets, Sun and changing Moon,
To yield the orderly succession of
The nights and days.

And then the good king died.
The royal prince was yet too young to rule,
So regents held the royal purse until
King Christian should ascend the throne, the fourth
To bear the name. Awhile the isle of Hveen
Enjoyed the care that Frederick had shown
Toward its embellishment. But Tycho's taste
For management had not improved; disputes
Arose and yielded less to cure, until
It seemed a rift would soon ensue between
The crown and pampered scientist. A score
Of years had passed with Tycho Lord of Hveen,
When Christian stopped the purse and gave unto
Another knight his patronage. When yet


NOVA MVNDANI SYSTEMATIS HYPOTYPOSIS
ab Authore nuper adinuenta, qua tum vetus illa Ptolemaica redundantia &c inconcinnitas, tum etiam recens Copernicana in motu Terræ Physica absurditas, excluduntur, omniaq; Apparentiis Cœlestibus aptissime correspondent.

In Tycho Brahe's theory of the solar system, the other planets revolved around the sun, but sun and moon revolved around the earth, situated at the center of the starry sphere.

Another spring had rolled around, the Dane,
The wizard of the stars, bade last farewell
To Hveen and its establishments, the like
The world had never seen. His smallest tools
And instruments to Copenhagen went,
As Tycho sulked and mumbled at his fate.

To Germany he turned his way, and this
King Christian took to be a sign that all
That Tycho held had been resigned. So said
The copy of the royal scroll that came
To Tycho Brahe, who wrote the king that he
Would yet relent and take his rightful place
Again on Hveen, if crown would guarantee
That moneys would again flow without end.
To this King Christian made reply in words
Severe, accusing Tycho Brahe of facts
That Frederick forgave. And so it was
That Denmark saw the last of Tycho Brahe,
The wizard of the stars, the Lord of Hveen.

In Hamburg wintered Tycho Brahe, the while
He put to rights his book on instruments;
It saw the press, and told of Hveen and all
The wondrous measuring machines that now
Would ne'er again be wielded by the Dane;
It told as well of Tycho's life and works,
All save his catalogue of stars, and this
He saved for manuscript for favored friends.
The thousand stars had not been quite complete;
For more than twice a hundred, only first
Of observations had been made. The Dane
Made full apology for them, in sheets
He sent to influential friends from whom
He sought to gain new patronage.

At length
From emperor of all the Roman realm,
From Rudolph, came the offer to provide
A shelter and a salary to Brahe,
And in his third and fiftieth year the Dane
Arrived in Prague, in old Bohemia,
In June. His family of wife and sons
And daughters, too, all born on Hveen, to share
This newest fortune settled there. One son
He sent to Denmark to retrieve the best
Of all his instruments, and at the end
Of that same year, they took up their abode
At Benatek, a score of miles from Prague.

A castle was this Benatek, with room
Most ample for the hospitality
That Tycho wished for entertaining those
Who came to him as pupils once again.
From Gratz came Kepler, new to Tycho's fold,
But scarce a novice, for the ink had dried
Three years on Cosmographic Mysteries,
The book that Kepler's hand had penned to tell
The geometric scheme he had devised
To fit the orbits of the wand'ring stars
That wheeled around the Sun. For Kepler held
Copernicus as having written truth,
Although refinement must be yet applied
To smooth the motions as Copernicus
Had left the theory. To Kepler, Mars
And all its vagrant tendency to stray
Aside from theory, did Tycho Brahe
Bequeath, for his own task. But Kepler scarce
Had seen the sheets containing Tycho's work
At measurement of place of Mars for years,
Than discord rose for want of access to
The emperor and open purse. The wars
That raged from time to time would not permit
Of Rudolph's stopping long at any place;
The couriers were slow in salary
Deliveries to Tycho and the house
Of pupils he maintained. From Benatek,
Young Kepler moved to Prague, and Tycho soon
Was forced to follow suit. He gave his best
To Kepler, seeing there perhaps the glow
Of genius that would yet unwind the skein
Of tangled thread the planets wove. In years
Beyond the end of Tycho's span, the truth
Would yield to Kepler, all because of Mars,
Whose orbit's eccentricity, revealed
By Tycho's faithful measures, gave the clue.
Not circles, as all scholars had assumed,
But planets' paths all are elliptical,
With Sun in focus fixed. No wheels on wheels
To complicate the flow of beauty pure
That pours from their geometry. And this
Attached to Kepler's glory stands, because
The Dane, his master and his friend, had set
To him the task of solving Mars' way.

But now the ev'ning of his life had come
To Tycho, who would never see his work
Brought to fruition in a way that he
Could not foretell, although the stars to him
Still held some measure of decree on lives
Of mortals here below. An illness struck
And laid him low, and in a few short days
He breathed his last, in Prague, as many miles
From Hveen as stars were in his list of those
Whose measures he had deemed complete at last.

"Ne frustra vixisse videar!" came
The cry from Tycho's lips, as in a dream
He lingered ere he died; so deep the lore
Of science buried was within his soul
That even in delirium he feared
That all he'd done might be adjudged as naught.
"That I might seem not to have lived in vain!"
A tortured cry that came from fevered lips
Of Tycho Brahe, whose life had been complete
With all devotion to the starry skies—
To measures without end, instead of now
And then a glance up to the night above.
If he had done naught else but shelter one
Who came to him from Gratz, to take from him
The places of the planet Mars, his score
Of life would have been marked as paid in full.

The people of the town where Tycho found
His latest home have put him in a tomb,
Where effigy pays honor to his name.
His grave is pointed out to all who come
To Tyn Church in Bohemia's Prague. They look
On him as having shown to them a glow
Of immortality that pays them well
For having sheltered him a while. And yet
To Denmark did this Tycho bring renown,
And best forgot is cause of peevish strife
That made an exile of the brightest star
She wears in brightly-jewelled crown. A Dane
He yet remained, a continent away;
His thoughts turned ever to the Sound and Hveen—
To gulls that flew so wild o'er garden walks
And towers of Uraniborg—to winds
That blew severe through winter days while all
Within the Castle of the Heavens snug
And warm remained—to that glad isle of Hveen
Where he had seen and brought such happiness
To those around him, family and friends.

The stars will ever shine with borrowed gleam
Above the isle where Tycho lived and sought
To seize the secrets of the universe.
The stars will honor Tycho Brahe, the while
This Earth, whose motions he denied, will wheel
And turn from now e'en to eternity.

R.K.M.

STARS OVER OHIO

Amateur astronomers share equally with professionals in the story told in an excellent pamphlet, *Stars Over Ohio,* published recently by Ohio State University in commemoration of the 50th anniversary of the founding of the Emerson McMillin Observatory at Columbus. The 23 observatory telescopes listed for Ohio range from the 69-inch reflector at Perkins Observatory in Delaware, third largest in the United States and fifth largest in the world (not counting the 200-inch), through the 12-inch refractor of Cincinnati Observatory, built in 1845, to Leslie C. Peltier's 6-inch comet seeker, and 5-inch refractors at Yellow Springs and Wooster.

Emerson McMillin was a charcoal burner, Civil War veteran, gas works manager, and public utilities magnate. His early interest in astronomy was culminated by his founding an observatory with a 12½-inch Brashear lens, with mounting by Warner and Swasey, two of Ohio's most famous early amateur astronomers. Dr. E. E. Barnard, of Yerkes Observatory, delivered the dedicatory address on June 16, 1896, and Dr. H. C. Lord became first director. Dr. Edmund S. Manson succeeded him in 1922, retiring this year. The new director is Dr. J. Allen Hynek, who will retain his present post as an astronomer at the Perkins Observatory, which is operated jointly by Ohio State and Ohio Wesleyan universities.

The pamphlet describes briefly other Ohio observatories, and reports on the work of such well-known amateurs as Mr. Peltier and the Reverend C. J. Renner, who has an 11-inch reflector at Castalia. In the '80's, F. M. Bookwalter, of Springfield, owned a 10-inch reflector and a transit instrument. The latter was used to correct a standard clock which was connected electrically with the bell of the fire station, half a mile away—probably one of the first time services in the country.

Most recently constructed telescopes in Ohio are the 13-inch refractor of the Burrell Memorial Observatory at Baldwin-Wallace College, Berea, and the Schmidt telescope of the Case School of Applied Science in Cleveland. The mirror of this instrument is 36 inches in diameter; its correcting plate is 24 inches across.

RUSSIAN ASTRONOMERS VISIT UNITED STATES

Nine Soviet astronomers have arrived in this country for a visit of several months to American observatories, at the invitation of the American Astronomical Society and Harvard College Observatory. They form one of the first large delegations of scientists to visit this country in recent months. Their leader is Academician G. A. Shajn, who is director of the Simeis Observatory in the USSR, now being rebuilt after having been destroyed during the war.

Others in the party are Academician V. P. Linnik, an expert in optical design, A. A. Mikhailov, O. A. Melnikov, B. A. Orlov, A. B. Severny, G. A. Monin, V. B. Nikonov. The only woman is Director Shajn's wife, who is also an astronomer.

NEWS NOTES

By Dorrit Hoffleit

ECLIPSE EXPEDITION

The National Geographic Society and the Army Air Forces are planning a joint expedition to observe the total eclipse in South America on May 20, 1947. They have chosen a site about 400 miles north of Rio de Janeiro, in an open field on a cattle ranch near the town of Bocayuva. This is on a plateau about half a mile above sea level; the duration of totality there will be about three minutes and 50 seconds, at 9:35 a.m. local time.

Participating in this expedition will be scientists from the National Bureau of Standards, Lick, Yerkes, and Georgetown observatories, and the Naval Research Laboratory. Dr. Lyman J. Briggs, former director of the National Bureau of Standards and now chairman of the National Geographic Society's research committee, will lead the expedition.

In addition to the usual black-and-white and color photography of the corona, observations will include flash spectra and measures of the polarization of coronal light. The positions of stars near the sun will be photographed to check the Einstein effect. Modern radio techniques will be used to detect changes in the earth's ionosphere. The AAF will furnish the necessary accurate time signals, obtain radiosonde meteorological data, and during the eclipse will maintain instrument-bearing observation planes at various altitudes.

SPECTROSCOPY OF ATOMS

In an address before the American Optical Society, Dr. W. F. Meggers, of the National Bureau of Standards, has reviewed the progress of the spectroscopy of atoms since 1913, when Niels Bohr first proposed his planetary model for hydrogen and ionized helium atoms. There was a lull of about a decade caused by the first World War, but from 1920 to 1940 some 1,500 relevant articles on atomic spectra were published. These Meggers and Scribner catalogued in 1941; a supplement for the past five years contains 1,000 more references, even though many significant advances are still shrouded in wartime secrecy.

Despite this stupendous progress during one third of a century, Dr. Meggers finds an even greater amount of spectrum analysis lies ahead. The original periodic table contained 92 distinct varieties of atoms, each of which in its neutral state produced one distinct spectrum. But ionized atoms give entirely different spectra, so if we remove one electron at a time from uranium atoms we should get 92 successively different spectra. Similarly, each atom has as many different characteristic spectra as it has planetary electrons. Thus, for the pre-war elements a complete atlas would contain 4,278 spectra. Of these, 3,800 are still completely unknown. The addition of war-born elements 93 to 96 increases the theoretically possible spectra to 4,656.

Not even the spectra of all the neutral atoms are yet completely known. Some of the elements are so scarce that optical spectra have not been observed because no samples have been available for study. Presumably some of these will become available as by-products of nuclear fission. Besides the mapping and identification of spectral lines, much work has been done and far more remains to be done on the hyperfine structure. Under high resolving power single "lines" are usually found to consist of complicated groupings of lines, depending on magnetic properties, electrical fields, nuclear structure, and the like.

Dr. Meggers speaks hopefully of newer methods of instrumentation which may speed up future spectral analysis. He concluded his talk noting that the solar astrophysicist may soon obtain the ultraviolet spectrum of the sun by means of spectrographs in high-altitude rockets (see *Sky and Telescope*, No. 60, page 7).

MRS. DAVID A. DUNLAP

A great woman philanthropist and patron to astronomy has passed away. On July 31, 1946, Mrs. David A. Dunlap, of Toronto, died after a lingering illness. It is primarily through her generosity that the University of Toronto has since 1935 been able to boast one of the best-equipped of modern observatories, the gift of Mrs. Dunlap and her son in memory of their husband and father. The David Dunlap Observatory, with Canada's largest telescope, a 74-inch reflector, is located at Richmond Hill, Ontario, a short distance north of Toronto.

ACCIDENT AT MOUNT WILSON

The observing platforms of many large telescopes look dangerous: a slight mishap in the darkness could lead to certain disaster. Fortunately, such accidents have been rare, but unfortunately there has been a serious one recently at Mount Wilson Observatory. Early in November, Dr. Alfred H. Joy, 64-year-old astronomer engaged in observing with the 100-inch telescope, fell more than 20 feet from the spectrograph platform onto the concrete pier below. He broke an arm, a shoulder, and a leg, but latest reports are that his general condition is very good.

GLOBULAR CLUSTER VELOCITIES

The velocities of the sun and other stars in our galaxy have usually been computed relative to the globular clusters, many of which are located on the fringes of the Milky Way galaxy. The clusters have been assumed to be relatively stationary so that they could be used as practical reference points. Now Dr. N. U. Mayall, of Lick Observatory, has found from a study of the radial velocities of 50 clusters that the globulars themselves have high random velocities of about 60 miles per second, whereas the random motions of stars in the sun's vicinity are only of the order of 10 miles per second.

The globulars also have a component of rotational velocity about the center of the galaxy, but this motion is small enough so that the heretofore computed velocity of the sun in its orbit about the center, namely 175-185 miles per second, is still correct.

TELEVISION AND MILKY WAY STATIC

Short-wave radiation originating in the Milky Way can actually increase the "noise" in a television receiver. Dr. O. H. Caldwell, editor of *Electronic Industries*, reports that on 60 megacycles a good television receiver is one with a noise factor of not more than four decibels when measured in the laboratory and under conditions where cosmic radiations can cause no disturbance. This same receiver will actually have an increased noise output of nine to 12 decibels when connected to a normal antenna. This noise output varies with the earth's sidereal rotation (about 23 hours and 56 minutes), the daily peak coinciding with the passing of the Milky Way overhead.

DIRECTOR AT HARVARD FOR 25 YEARS

At a dinner in Cambridge, October 30th, Dr. Harlow Shapley was honored on the completion of 25 years as the director of Harvard College Observatory. In addition to observatory and university staff members and friends, the nine Russian astronomers who had just arrived at Harvard attended the dinner and presented Dr. Shapley with a scroll bound with covers bearing a ruby.

NEW DIRECTOR AT MICHIGAN

Dr. Leo Goldberg, of the staff of the McMath-Hulbert Observatory, has been appointed chairman of the department of astronomy at the University of Michigan, and director of the University of Michigan Observatory. Dr. Orren C. Mohler has been made assistant director for the McMath-Hulbert Observatory.

AMERICAN ASTRONOMERS REPORT

Here are highlights of some papers presented at the 75th meeting of the American Astronomical Society. Complete abstracts will appear in the Astronomical Journal.

Interstellar Temperatures

FOR SOME TIME it has been realized that the temperature of matter between the stars is very different for gases and for small, solid grains of the size of dust or smoke particles. The solid grains radiate their energy so effectively that out in space, far away from any one particular star, their temperature falls to a very low value, within a few degrees of −459° Fahrenheit, the absolute zero at which all heat is gone. Gases, on the other hand, radiate energy so poorly, especially at lower temperatures, that if left to themselves out in space they come to about the same temperature as that of the surface of a typical star.

Dr. Lyman Spitzer, Jr., of Yale University Observatory, has found that under certain circumstances interactions between gases and solid grains will cool down the interstellar gases considerably. In some regions of space the gases, consisting predominantly of atomic hydrogen, are ionized, and in such regions the radiant energy absorbed in repeated ionizations keeps up the gas temperature to nearly 20,000° F. However, in those regions where most of the gases are not ionized, the gas temperature may be reduced to a low value by the cooling effect of the solid grains. How low the temperature may fall is still quite uncertain, since information is lacking on the many physical processes which affect the final temperature. But temperatures similar to those found on the earth may be quite possible in interstellar space.

The Yale astrophysicist pointed out that the existence of low gas temperature is significant in that it may facilitate the condensation of gas into additional solid grains—an important step in the continual formation of stars from diffuse matter.

Another Sub-dwarf

A STAR of the sub-dwarf type has been found as part of the system H. D. 43246, from 30 spectrograms taken at Dominion Astrophysical Observatory at Victoria, B. C. Dr. R. M. Petrie reported that this system is not a spectroscopic binary showing two spectra in the ordinary sense, but that the spectrum of the second star is detected through the peculiar behavior of the hydrogen lines and the anomalous appearance of the K line of ionized calcium in the *F*-type spectrum of the brighter star.

The broad absorption of the K line provides a window through which we can see the K region in the *B*9-type spectrum of the companion star, the sub-dwarf. This is similar to the way in which a spectroheliogram of a solar prominence is taken through the hydrogen or calcium lines in the sun's spectrum. It is only because of this fortunate circumstance that we are able to measure the velocity of the fainter star.

In this case the period of the binary system is about 23 days; the minimum masses of the stars are about 0.7 and 1.6 times the sun's mass, the fainter star being more than twice as massive as its brighter companion. This violates the usual mass-luminosity relation and places the companion star well below the normal position of late *B*-type stars in the Russell diagram. It is a small, dense star, its volume being less than 1/1,000 normal and its mean density several thousandfold that usually found in the late *B* stars.

Spectrum of the Orion Nebula

OBSERVATIONAL EVIDENCE is the determining factor in the acceptance or rejection of many astronomical theories. The report by Dr. Jesse L. Greenstein, of Yerkes Observatory, on the spectrum of the Orion nebula is an example of how observational techniques are being developed to keep pace with refinements and extensions in our theories of the nebulae and other kinds of interstellar matter.

At McDonald Observatory in Texas, Yerkes astronomers have started a program of observing the spectra of various nebulae, their goal being to determine the temperatures of the nebulae by observational means. For the Orion nebula, spectra were taken with the Schmidt camera of the two-prism quartz spectrograph of the McDonald Observatory. The spectral region studied, from 4800 to 3200 angstroms, included the limit of the Balmer series of hydrogen lines, where it was found that the emission of the lines of hydrogen just to the red of the series limit is appreciably weaker than the energy to the ultraviolet of that limit. At the Balmer limit, the energy in the continuum rises about four times. The continuous emission is due to the capture of electrons by ionized hydrogen atoms, in the second quantum state. If the energy distribution in the ultraviolet is interpreted as that of the recombining hydrogen atoms, the electrons must have a temperature near 65,000° centigrade. This improbably high temperature can be replaced by a reasonable value, near 12,000°, if it is assumed that the hydrogen in the nebula is sufficiently opaque to reabsorb the energy in the Balmer continuum.

A Yerkes Observatory photograph of the nebula in Orion, showing the wispy character which would probably disappear if the photograph were taken in ultraviolet light.

If the nebula is thus opaque in the ultraviolet, Dr. Greenstein suggests that on photographs of the nebula in ultraviolet light the wispy, filamentary structure characteristic of ordinary photographs should disappear. He has been able to compute the space density of the hydrogen gas, as well as the size of the region where the hydrogen is not ionized; the mass of the nebula should be about 10 times that of the sun.

Eclipsing Double Stars

MORE THAN half a dozen papers specifically concerned eclipsing binaries, indicating the growing importance of stars of this type in our study of stellar constitutions. Today, much of the work on the light variations of variable stars of this type is done with photoelectric devices attached to large telescopes. Very minute fluctuations in light can be detected by such apparatus.

Dr. John B. Irwin, of the University of Pennsylvania's Flower Observatory, reported an analysis of the light curve of the star U Sagittae, from observations made in 1941 using a photoelectric photometer attached to the 36-inch refractor of Lick Observatory.

The 36-inch reflector at Steward Observatory in Tucson, Ariz., was used with a photoelectric photometer in 1938-1939, to obtain the light curves of three stars: AG Virginis, AR Lacertae, and TX Ursae Majoris. The analysis of these curves was reported by Frank Bradshaw Wood, of Princeton University Observatory.

At Washburn Observatory, where the photoelectric equipment is attached to the 15-inch refractor, TX Ursae Majoris has also been observed, on 40 nights from 1935 to 1942. A measure of the precision of the observations is indicated by the probable error of a single normal magnitude of only 0.0046. Intermediate elements for this star have been worked out by Olin J. Eggen. Other studies at Washburn, of the stars AR Aurigae and RZ Cassiopeiae, were reported by Dr. C. M. Huffer.

The last-mentioned star, RZ Cassiopeiae, has a variable period. The star FL Orionis, studied by Dr. Balfour S. Whitney, of the University of Oklahoma, also appears to have a changing period. Some dozen years ago its period and time of minimum were determined by Piotrowski. Photographic and photovisual observations for the past five years place the time of primary minimum nearly 1½ hours later than predicted by the earlier elements. Either these must be assumed to be in error by that large amount or a variation in period accepted. For the five years of the current observations the star's period has been about 2½ seconds longer than it was 12 or 13 years ago.

The star V444 Cygni consists of two very hot stars, one of type *O* and one a Wolf-Rayet star (bright-band spectrum). This eclipsing system presents an excellent opportunity to analyze the characteristics of the extended atmosphere known to surround all Wolf-Rayet stars. Dr. Zdenek Kopal and Martha B. Shapley, of Harvard College Observatory, have found this component of V444 Cygni to be a diffuse object of gradually increasing opacity. If a completely opaque core exists, it must be of relatively small dimensions, not over 11 times the sun's diameter.

The density of the Wolf-Rayet envelope is very low, but it is so full of free electrons that they produce the observed opacity by scattering the light of the *O* star when it shines through the envelope. But the envelope cannot be in electrical and dynamical equilibrium, for then the electron gas producing the peculiar absorption effects during eclipse would dissipate completely in about 300 years, an astronomically insignificant interval. Therefore, the electrons must share the outward motion of the ejected ions whose lines dominate the spectrum of Wolf-Rayet stars in general. Thus, both electrons and ions constituting the star's extended atmosphere must be constantly fed from the core of the star.

Triple Periods

UNUSUAL STARS include 12 Lacertae, a short-period intrinsically variable star. Because of the varying amplitude of its radial velocity curve, this star was placed on the observing list at the Goodsell Observatory of Carleton College. Dr. E. A. Fath reported the correlation of observations comprising 63 maxima, one each in 1917, 1919, and 1920, and 60 in the years 1937-1940.

Although it proved impossible by the use of three empirical curves of different periods and amplitudes to reproduce quantitatively the actual light curves, probably as a result of systematic differences in the observational data, Dr. Fath has concluded that this star has three periods. First, there is a fundamental variation about 0.193 days long with a range of 0.08 magnitude; then, a second period of 0.165 days and amplitude of 0.03 magnitude; and a third of 0.132 days and 0.02 magnitude.

Rare Spectral Types

DEARBORN OBSERVATORY of Northwestern University has been investigating for many years the stars of spectral types *R* and *N* from declination —4½° to the north celestial pole. *R* and *N* stars are those in which bands of carbon and cyanogen are very strong, the *N* stars being very red. Oliver J. Lee, Thomas J. Bartlett, and Greenville D. Gore, all of Dearborn Observatory, have found that there is a high concentration of both *R* and *N* stars toward the galactic plane, with the *N* stars more concentrated than the *R* stars. Also, the maximum concentration of the *N* stars is in a direction opposite to that of the center of the galaxy in Sagittarius, a tendency noted in 1941. The *R* stars appear to avoid the *N*-star nest around galactic longitude 170° and to be well distributed between 0° and 150°.

At the opposite end of the spectral sequence are the *O* stars, the hottest of normal stars and quite rare. The Dearborn survey included *Oe* stars, but only four of this type were found which were not already recorded in the Henry Draper *Catalogue of Stellar Spectra.*

ASTRONOMICAL SOCIETY TO MEET IN CAMBRIDGE

The Christmas meeting of the American Astronomical Society will be held in Cambridge, Mass., from December 27th to 30th inclusive, in conjunction with the general meeting of the American Association for the Advancement of Science. The AAS meeting will include celebration of the 100th anniversary of the establishment of Harvard College Observatory on its present site. There will be only one regular session for papers, but four symposia and other special events.

On Friday, December 27th, both morning and afternoon sessions will be devoted to a symposium on "Interstellar Matter," with the invited speakers including Dr. J. J. Nassau, who will give his address as retiring vice-president of Section D of the AAAS. Saturday morning there will be a symposium on "Electronic and Computational Devices of Interest to Astronomers," followed by a symposium on "Eclipsing Binaries" in the afternoon. The evening will be featured by the first annual Henry Norris Russell lecture, to be delivered by Dr. Russell himself.

Open house at the Oak Ridge station of Harvard Observatory during the daylight hours on Sunday, together with the session for papers that afternoon, will be followed by the society dinner that evening. At 8:15 p.m., in a combined session of the Society of Sigma Xi and the AAS, Dr. Harlow Shapley will give an address as retiring president of the American Astronomical Society. This will also be the Christmas lecture of Sigma Xi.

Monday's morning session will be a joint meeting with meteorologists and ionosphere experts in a symposium on "The Gaseous Envelope of the Earth." Harvard Observatory will hold open house for AAAS members and their guests from 4:00 to 7:00 p.m. that same day.

Amateur Astronomers

Highlights of the AAVSO Annual Meeting

FROM THE ACCOUNT of the recorder of the American Association of Variable Star Observers, describing the events of the 35th annual meeting of the society, held in Cambridge on October 11th and 12th, the following highlights are principally taken. The full report will appear in Variable Star Notes in *Popular Astronomy*.

Some 50 to 60 members and guests attended the business sessions; 70 were present at the dinner on Saturday evening. Total new members for the year are nine life and 53 annual members. The council gave favorable consideration to joining the Amateur Astronomers League, as did also the business session, but the final decision was left to a mail vote by the entire membership. Four members of the society died during the year, including David B. Pickering and the well-loved veteran observer, Eugene H. Jones, of Goffstown, N. H.

At the meeting Friday evening with Bond Astronomical Club members as guests, Professor George Z. Dimitroff, of Dartmouth University, described astronomical conditions in Germany and Japan as he saw them soon after the end of the war.

Committee reports were heard at the Saturday morning session. The solar division now has 74 members, with 56 active observers. In two years, 11,940 observations have been reported. Reports on sunspot frequencies are now being sent to the U. S. Bureau of Standards and to a dozen interested individuals and institutions. A small group led by Dr. James C. Bartlett, of Baltimore, is endeavoring to determine whether or not there is a correlation between solar granulation and the sunspot cycle.

Foreign observers of variable stars are once more able to send in regular reports, with the result that 44,272 observations make the total for the year, the greatest number since before the war. Cyrus F. Fernald, of Wilton, Me., led with 5,016 estimates. Next came R. P. de Kock, of Cape Town, South Africa, with 4,272. Of 2,425 observations reported by Constantin Chassapis, of Greece, 1,073 were made during the war. From foreign countries came 40 per cent of the total observations. The Reverend T. C. H. Bouton, of St. Petersburg, Fla., is still making observations although he is 90 years of age. The society's honor roll of persons who have contributed more than 10,000 observations contains 25 names.

At the afternoon session, Dr. Sergei Gaposchkin spoke on some special variables, while Dr. Cecilia Payne-Gaposchkin described the non-existence of the variable Y Ceti. H. R. Petzold, observing the erratic star Gamma Cassiopeiae, has found a possible periodicity in its current light fluctuations. The sun came in for a large share of the discussion, which included a description by H. B. Chase of the effect of sunspot emanations on radio reception. David W. Rosebrugh gave a demonstration of his special observing devices and wide-field eyepieces made from war salvage.

AAVSO President Charles H. Smiley, Brown University, acted as toastmaster at the society dinner Saturday night. In accordance with custom, Dr. Harlow Shapley presented some highlights of astronomy during 1946, including:

The Giacobinid meteor shower, finest display of the century, and marking an achievement of accurate timing by celestial mechanicians; the appearance of two more recurrent novae, T Coronae Borealis and Nova Sagittae 1913; the measure of star diameters during occultations, by Dr. A. E. Whitford, of Washburn Observatory; radar to the moon and back again; the V-2 rocket experiments and the resultant discoveries of the great intensities of cosmic ray showers at high altitudes; the impending formation of the Amateur Astronomers League.

Dr. William L. Holt Dies

A few days after attending the October 12th meeting of the American Association of Variable Star Observers in Cambridge, Dr. William L. Holt, well-known amateur and variable star observer, died. He was living at Amherst, Mass., where he had engaged in war work, but was known to his friends as a resident of Scarboro, Me., Tucson, Ariz., and Winter Park, Fla., between which places he regularly carried his 8-inch reflector.

It was Dr. Holt who made the millionth observation of a variable star announced at the spring meeting of the AAVSO (see *Sky and Telescope*, No. 56, page 3). In the 12 years he was a member of the society he amassed about 12,000 observations. At the time of his death he was a member of the AAVSO council.

THIS MONTH'S MEETINGS

Chicago: On Tuesday, December 10th, at 8:00 p.m., the Burnham Astronomical Society will meet at the Chicago Academy of Sciences Auditorium. Wagner Schlesinger, director of the Adler Planetarium, will talk on "The Star of Bethlehem."

Cincinnati: The annual dinner meeting of the Cincinnati Astronomical Association will be held on Thursday evening, December 12th. For further information, communicate with Dan McCarthy, 1622 DeSales Lane.

Geneva: On Tuesday, December 17th, at the meeting of the Fox Valley Astronomical Society, Geneva, Ill., Dr. H. G. Taylor, of Wheaton College, will speak on "Joshua's Long Day." The meeting will be held in the Geneva City Hall, at 8:00 p.m.

Indianapolis: At the meeting of the Indiana Astronomical Society, December 1st, 2:15 p.m. at Odeon Hall, a "1946 Review" will be conducted by the board of officers of the society.

Madison: Dr. C. M. Huffer, of Washburn Observatory, will speak on "Life and Works of Tycho Brahe" at the meeting of the Madison Astronomical Society on Wednesday, December 11th, 8:00 p.m. at Washburn.

New York: "Frontiers of Space," by Major Alexander P. deSeversky, will feature the December 4th meeting of the Amateur Astronomers Association, held at 8 o'clock in the Roosevelt Memorial building, American Museum of Natural History.

Philadelphia: The lecture before the Rittenhouse Astronomical Society on Friday, December 13th, will be given by Dr. John Q. Stewart, of Princeton University Observatory. His subject will be "A New Use for Astronomy." The meeting is at 8:00 p.m., probably in the Morgan Physical Library of the University of Pennsylvania.

Pittsburgh: On Friday, December 13th, the Amateur Astronomers Association of Pittsburgh will meet in the Buhl Planetarium, at 8:00 p.m. Leo J. Scanlon will speak on "Russell W. Porter," in connection with the celebration of Russell W. Porter day.

Rochester: On December 6th, the astronomy section of the Rochester Academy of Sciences will hold a fun night, with astronomical games, refreshments, and telescope observations from the roof terrace of the Rochester Museum of Arts and Sciences. The meeting will start at 8:00 p.m., in Room 317.

On December 19th, the astronomy section will sponsor the regular monthly meeting of the academy, at which Dr. Walter O. Roberts, of Harvard's High-altitude Observatory, Climax, Colo., will speak on "The Solar Corona Without an Eclipse." The meeting is at 8:00 p.m., in the Rochester Museum of Arts and Sciences.

Washington, D. C.: Rear Admiral Lee Otis Colbert, director of the U. S. Coast and Geodetic Survey, will be the guest speaker at the monthly meeting of the National Capital Astronomers, on Saturday, December 7th, at 8:00 p.m. in the Commerce Department Auditorium. His lecture subject will be, "Hitching Our Country to the Stars."

Amateur Astronomers League Ratifications

Word has come from James B. Rothschild that as of November 9th, one month after the mailing of the letter circulating the by-laws of the Amateur Astronomers League, eight societies had ratified. They are, in order of receipt:

Association of Amateur Observers, New York City.

George Gregory Memorial Observatory, Paul Revere Boys Club, Jersey City, N. J.

Detroit Astronomical Society, Detroit, Mich.

Portland Amateur Telescope Makers and Observers, Inc., Portland, Ore.

Popular Astronomy Club, Moline, Ill.

The A.T.M. Astronomical Club of San Diego, San Diego, Cal.

National Capital Astronomers, Washington, D. C.

Eastbay Astronomical Association, Oakland, Cal.

Added in press, November 15th: Amateur Astronomers Association, Kalamazoo, Mich., and the Astronomical Society of Maine, Portland, bringing the total to 10 societies.

Fifth National Convention in Philadelphia

On the invitation of the Rittenhouse Astronomical Society and the Amateur Astronomers of the Franklin Institute, the Fifth National Convention of Amateur Astronomers will be held in Philadelphia on July 4-6, 1947. This will be, presumably, the first national convention of the Amateur Astronomers League.

Eclipse Observer Resigns Office

The president of the National Capital Astronomers, Leo Scott, has resigned his office during his second term. He will accompany the National Geographic-Army Air Forces eclipse expedition to Brazil next spring, and finds the pressure of other duties too arduous to complete his term. He will be succeeded by Miss Mabel Sterns, long an active member of the NCA, and editor of its publication, *Star Dust,* since its inception.

The original group of amateur telescope makers at Springfield, Vt., with Russell W. Porter fourth from left.

From One ATM to All the Others

A brief autobiography by Russell W. Porter

MY FIRST URGE to make a mirror was inspired by a chance reading in *Popular Astronomy* of an article by an obscure coffee merchant in Decatur, Ill. This was about 1914. It was a description of how he made a reflecting telescope, and through correspondence I obtained a little book entitled, *Glass Working by Heat and Abrasion,* by Paul Hasluk. I well remember the old woodcuts portraying the knife-edge shadows, and my own efforts to produce them on a glass disk. It was hard sledding compared to what the present generation of glass pushers has, for they find all steps clearly given in *Amateur Telescope Making.*

Now I must describe the man who did so much to encourage me in this work. I refer to the late Governor James Hartness [of Vermont], who furnished every possible facility in helping me in my work. At that time he was building his 10-inch refractor mounted over an enclosed observing room. I was living in a fishing village on the Maine coast, and one day a letter came from him with a big wad of bills in it, telling me to buy a lathe and machine tool equipment to go with it. Later, there arrived two 16-inch disks from John Brashear. I shall never forget the thrill I had on top of a stepladder as I brought the moon's image into view under this powerful scope. Next, Governor Hartness wired me to pack up and go to the Bureau of Standards in Washington (this was during World War I). And from there I joined him in his factory at Springfield where the first group of mirror makers was started, and which finally developed into Stellafane.

(Continued on page 23)

This picture of Leo J. Scanlon (left) and Russell W. Porter was taken about seven years ago when the latter stopped off in Pittsburgh on his way to Stellafane.

FOR A TALK before the Porter Day meeting of the Amateur Astronomers Association of Pittsburgh, Leo J. Scanlon wrote to Russell W. Porter, well-known mentor of amateur telescope makers, and requested more exact data on his life and travels. On December 13th, Mr. Scanlon will read this response by Mr. Porter and will add some personal incidents from their 16 years' acquaintance. Russell W. Porter has been an honorary member of the Pittsburgh group for several years, and he will receive a scroll containing the signatures of all members present at the Porter Day meeting. Also, there will be exhibited some of the original Porter drawings, sketches, and pastel paintings. The establishment of Russell W. Porter Day was proposed by C. R. Raible and adopted at the meeting of telescope makers at Stellafane last August. Permission to publish Mr. Porter's letter here has been obtained by Mr. Scanlon.

Latimer J. Wilson, Hayden B. Clements, Jr., and Alese Clements, of Nashville, Tenn., took the above picture showing the head of Draco in the center and five meteors radiating from it. A sixth meteor, to the left of the star trail of Xi Draconis, was stationary, so it appears as a bright point. It was seen visually just before the end of the 15-minute exposure at 10:18 CST. Ansco SS Pan film pack was used in an Anticomar camera, f/2.9, 12.5 cm. focal length, taking a 2¼ x 3¼ picture.

COSM

The Giacobini

ON THE NIGHT of October 9-10, 1946, the Giacobinids provided a spectacle which can without doubt be called the greatest single predicted event of the century. Comets and eclipses have, of course, provided spectacular and in some respects more awesome demonstrations of nature's might, but the beauty of this intense meteor shower, combined with the knowledge that one of the significant mysteries of the solar system is yielding to man's thought, made it an occasion never to be forgotten by those who observed it.

Shortly after the November issue went to press in mid-October, reports began to pour in from all parts of the country, indicating that complete cloudiness was not nearly as widespread as had originally been thought. The western half of the country was favored with quite clear skies, and from Florida and other southern states very favorable reports have been received. Some individuals and groups used planes to observe in the modern style or to make a last-minute change in location.

At the height of the shower, which all observers agree occurred at from 3:45 to 3:55 Greenwich civil time, October 10th, a single observer could count from 60 to 100 meteors per minute, most of the reports for a five-minute interval showing from 300 to 500 meteors counted. This was true in spite of the strong moonlight, which reduced the limit of visibility to between 3rd and 4th magnitude at most places. By just what factor the single observer's count should be multiplied to determine a total for the entire sky is not certain, but Dr. Fletcher G. Watson, from a preliminary examination of the reports, estimates that the space density of the swarm of meteors which the earth intercepted on this occasion was just about the same as that in 1933, when the shower was seen in Europe but not in the United States. In a future issue of *Sky and Telescope,* Dr. Watson will present a summary of his analysis of the scores of reports received from all parts of the country.

Photography of the shower was attempted by some observers, and nearly every camera recorded a number of meteors on one exposure of a few minutes' duration. The faintness of the trails makes most of the submitted pictures unreproducible, however, especially since the strong moonlight caused considerable fogging of the sky backgrounds. On this page are two pictures which, with the back cover plate, represent the most striking results we have received to date. For quality of the print and for showing the radiant position and a large number of meteors at the same time, the back cover picture is outstanding. It was taken by Kenneth Spain, a student of astronomy at Vanderbilt University, Nashville, Tenn., and transmitted by Dr. Carl K. Seyfert, director of Barnard Observatory at that university. A 12-minute exposure, from 9:40 to 9:52 p.m. CST, was taken with an f/4.5 Speed Graphic camera using Agfa Super Pan Press film. Dr. Seyfert writes that 40 meteor tracks are clearly shown on the original film; the print he sent bears about 38 trails, some hardly visible. Careful examination of the back cover should show a majority of these trails. During the time of the exposure, meteors were being observed visually at the rate of one per second, with a 3rd-magnitude limit of visibility. As many as four meteors were seen simultaneously at several different times.

Latimer J. Wilson, also of Nashville, Tenn., was successful in an elaborate photographic program. His picture reproduced here is only one of several we could have selected. Amateurs at Jacksonville sent in several worthy meteor photographs, as well as pictures of their observing groups. John Holeman, of Richland, Wash., also had a successful photographic program. Only a portion of his best negative is shown here; the original showed about 45 trails.

Simultaneous meteors were a bugaboo for many who tried to keep an accurate count during the height of the shower. As a result, some observers who had long since stopped trying to count by magnitudes were forced to stop counting entirely. Those who maintained reliable counts from early in the evening through maximum and well past are to be commended on their stamina, as well as on the scientific value of their work. Several observers submitted curves to show how the meteor shower built up to a peak and then rapidly faded. Data of this kind must await further checking and analysis before it is ready for publication.

From those reporting observations made through the nights of October 8th and 10th, it is evident that before and after the main shower only a few stray Giacobinids were encountered by the earth. On those nights the number of meteors seen by a good observer in a clear sky seemed almost below normal for the second half of the year.

Science Service, in Washington, D. C., sent in advance of the shower a special request to Army Air Forces Air Weather Service stations all over the world. Observers were asked to face northwest and count meteors by 10-minute intervals. A large number of stations co-operated in making precise observations, and Science Service has distributed to interested astronomers verbatim copies of some 90 reports, covering the nights of October 8th, 9th, and 10th.

Many of these reports came from Europe, particularly Germany, where the shower was observed, but probably not as intense as it was in the Western Hemisphere. At Zug Spitze, Germany, 105

MIC FIREWORKS

obinid meteor shower appeared on time and was widely observed.

meteors were seen during a 10-minute interval. Observers in Alaska were clouded out, but some Giacobinids were seen as far south as British Guiana and Trinidad.

Dr. Peter M. Millman writes from the Dominion Observatory, Ottawa, that at noon on Wednesday, the 9th, the meteorological office could give him no hope of clear weather, but that the Royal Canadian Air Force kindly lent him a Dakota to fly anywhere with instruments and observers. Packing all equipment in about 40 minutes, they flew to North Bay, Ont., where they set up cameras on the roof of the control tower of the airport; weather conditions were perfect. With three direct cameras and two spectrographs behind one rotating shutter, Dr. Millman secured in four hours approximately 165 direct photographs and 20 meteor spectra.

Walter H. Haas, of Albuquerque, N. M., was one of a group of six from the University of New Mexico who observed from a B-29, flying near 20,000 feet. He reports maximum between 8:50 and 8:55 p.m. MST, when the rate "was about 100 a minute, in spite of the full moon and the dirt on the plastic blister."

Oscar E. Monnig, with prospects of clouds at Ft. Worth, Tex., "flew to El Paso and got a good view, in clear skies, but had to give up a photographic program. My highest five-minute rate was 158 meteors but, with less conscience, one could easily have doubled this amount."

Below is a list of correspondents (in addition to those mentioned last month) who reported on the meteors, most of them in response to Dr. Watson's request, up to November 8th. Space permits us to mention only the name of the person transmitting each report, although in many cases other observers participated and recorders labored faithfully. Thanks are due to all of these people whose time and energies went into observing and recording the shower; their results have definite scientific value, particularly since this is the most outstanding modern case of association between meteor swarms and the path of a comet. We should not forget, also, hundreds of amateurs and professionals who made elaborate preparations only to be disappointed by the weather.

Arizona: Glenton G. Sykes, Tucson. **Arkansas:** C. B. Stephenson, Little Rock. **British Columbia:** E. K. White, Chapman Camp. **California:** James Bray, Burlingame; Frank Elliott, San Diego; J. C. Hayes, Inverness; Tom A. Keene, Burbank; Dr. Henry Power, Palo Alto; James R. Seaward, Patton; Holgate Thomas, San Rafael; F. K. Vreeland, Mill Valley. **Colorado:** Norman Thomas and Donald Fingado, Alamosa.

Florida: A. J. Abbe, Winter Park; O. J. Farrey, Miami; Mrs. Elizabeth Lichty, Daytona Beach; N. K. McKinnon, Panama City; Eirene Milligan, Ormond Beach; E. L. Rowland, Jr., Jacksonville; R. F. Suber, Wewahitchka. **Illinois:** L. Schmidt, Elgin; Carl H. Gamble, Moline. **Indiana:** Fred Deck, Fort Wayne; Martha H. Mosier, Martinsville; R. W. Noland, Fort Wayne. **Iowa:** F. E. Bissell, Jr., Dubuque; Robert Davis, Des Moines; Dr. C. C. Wylie, Iowa City.

This picture covers about half of a 3½ x 4½ negative made by John Holeman, of Richland, Wash., containing 45 meteor trails, most of them very faint. Deneb made the bright star trail in lower center. The hooks were caused when an excited child knocked over the camera. Some fainter meteor trails were caught as the camera lay on its side before the shutter could be closed. Exposure from 8:10 to 8:30 PST, B&J Press camera, Kodak f/6.3, 6¾-inch lens, Eastman Tri-X Pan film.

A portion of the observing group of the Jacksonville Amateur Astronomers Club which gathered at the home of E. L. Rowland, Jr., in Jacksonville, Fla.

Kansas: Owen Gingerich, North Newton; Orland Kolling, Wichita; Ernest L. Quick, Bellefont. **Kentucky:** Edwin Hare, W. C. Kirk, Owensboro. **Maine:** Mrs. G. Leon Aiken, Dexter. **Michigan:** John W. Broxholm, Detroit; Charles E. Hundley, North Branch; Max E. Kester, Kalamazoo; Dr. Hazel M. Losh, Ann Arbor. **Minnesota:** Miss Kyle M. Petersen, St. Paul. **Missouri:** Edward F. Bowman, Kansas City; Floyd F. Helton, Fayette. **Mississippi:** Mrs. Albert Bonelli, Vicksburg.

Nevada: G. Bruce Blair, Reno. **New York:** Stephen Fybish, Jackson Heights; Raymond Missert, Buffalo; Philip Scanlin, Carthage; Paul W. Stevens, Rochester; George W. Walker, Perry. **Ohio:** Robert Blickensderfer, Foster; Alika K. Herring, Middletown; Walter Houston, Cincinnati; Frank Myers, James L. Russell, Cleveland; P. L. Sagebiel, Dayton; Russell B. Stewart, Yellow Springs. **Oklahoma:** R. E. Kostka, Yukon; Paul McLennan, Frederick.

Oregon: Charles G. Benson, A. V. Goddard, Esther Penwell, Portland; J. Hugh Pruett, Eugene; Carl P. Richards, Salem. **Tennessee:** Latimer J. Wilson, Nashville. **Washington:** Clinton De Soto, Jr., Colfax; John Holeman, Richland; Audrey Korhel, J. Franklin Peters, Seattle; Emily Ford Russell, Tacoma. **Wisconsin:** Robert Bard, Appleton.

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BOOKS AND THE SKY

SCIENCE AND THE PLANNED STATE

John R. Baker. The Macmillan Company, New York, 1945. 120 pages. $1.75.

EVERYONE interested in trends of modern science should read this book. It is a very one-sided presentation of a point of view, but so well argued that the reader is almost forced to go out of his way to obtain **The Social Relation of Science** (Macmillan, 1941) by J. G. Crowther, which **Science and the Planned State** is apparently written to refute.

To appreciate fully Dr. Baker's book, one must be thoroughly conversant with the opposing viewpoint, stated in his own introduction as follows:

1. Science exists to serve the material wants of man.

2. Central planning makes for efficiency, and scientists have a duty to press for its introduction in their own sphere. The central authority would know the material wants of the community, and would be able to direct the course of research in such a way as to relieve these wants as speedily and economically as possible.

3. Since scientists are accustomed to do everything methodically, and since they must recognize that central planning would improve the efficiency of their own work, they should press for the adoption of a scientific scheme of central planning in all departments of life.

"The purpose of this book," says Dr. Baker, "is to consider these three propositions. When they are stated like this, in moderate terms, a case is presented which calls for careful consideration. Nevertheless, the arguments are sometimes stated in an immoderate form which is not only not helpful, but positively threatening. Nothing less than a realization of the gravity of the situation would induce me to copy those with whom I disagree by ascending the pulpit . . . . The purpose of this book is to suggest that progress lies in another direction."

The direction of progress which the author advocates is completely free, unfettered, and undirected scientific inquiry. This reviewer is in complete agreement with the author's general opinion that scientific progress is best achieved by the flexibility of research in pure science, where the chance and often most important discoveries are made as by-lines to the main point of the research being followed. He is also in complete sympathy with the author in the point of view that totalitarianism, when applied to science, impedes rather than quickens real scientific progress. However, the force of Dr. Baker's arguments seems somewhat weakened by being pushed too far. He advocates such freedom of inquiry that he believes science is best served by the solitary worker. "The trouble with a team is that directly a man has joined it, he doesn't bother to have ideas any more."

A few hundred years ago, it was possible for a man to be conversant with the entire scope of scientific knowledge and to earn his living by some other pursuit besides. In such an atmosphere, the solitary worker could be expected to produce effective results. But the extent of 20th-century science is so vast that the constant interchange of ideas among highly technical specialists makes team research by far the most inspiring and productive way of advancing scientific knowledge.

The final chapter of the book, entitled "The Duties of Scientists to Society," lies on the most controversial ground, probably because it must necessarily be the expression of the author's own ideas,

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which are not subject to any particular proof or disproof. Perhaps it is best to quote Dr. Baker's conclusions directly.

"The purpose has been to suggest various ways in which the scientist may use his special knowledge, talents and outlook to make the world a better place, apart from the fulfillment of his primary duty in research or teaching. Scientists have been urged to regard their subject as existing solely for service to man's material wants, to press for the central planning of scientific research, and to ally themselves with political groups which advocate the central planning of society in general. Scientists should not accept this advice, for three reasons:

"First, science does not exist solely to serve man's material wants.

"Secondly, any thoroughgoing scheme for the central planning of research would gravely damage science.

"Thirdly, totalitarianism is precisely the form of government that is least in accord with scientific principles; for scientists accept the authority of no one and recognize the necessity for liberty.

"The purpose of this book is to give the reasons why these answers are valid, and to suggest social responsibilities that scientists can undertake without sacrifice of the ideals they ought to serve. By undertaking these responsibilities in addition to their primary duties, scientists can show the reality of their belief in the liberty, fraternity, and inequality of man."

SANBORN C. BROWN
Massachusetts Institute of Technology

THE WORLD OF NUMBERS

Herbert McKay. Cambridge University Press and the Macmillan Company, Cambridge and New York, 1946. 198 pages. $2.50.

THE WORLD ABOUT US is certainly made up mostly of things which can be measured and it is thus in a very real sense a "world of numbers." There are those who will contemplate with interest the statements that the volume of land above sea level in Europe is three-fourths of a million cubic miles, that the water of Lake Superior would take 124 years to flow over Niagara Falls, that the length of the tropical year is 0.999961 times the length of the sidereal year (which is 365.25636 mean solar days), and that the average density of the earth is about 4 2/13 tons per cubic yard or 344.3 pounds per cubic foot. Such numerical information fills a large part of a motley assortment of chapters, for all of which there is no index.

As a bone in the jaws of a hungry dog, each morsel of numerical fact is gnawed and worried and crushed to obtain from it the last possible measure of interest. Units are converted and reconverted. Comparisons abound and pyramid one upon another. But there is far too little discussion of underlying meaning; the "**world** of numbers" tends to be obscured by the **numbers.**

A substantial fraction of the numerical examples are drawn from fields of astronomy, so the amateur astronomer will find many bits and pieces to fit his hobby. Most American readers will discover for the first time that they live in a small

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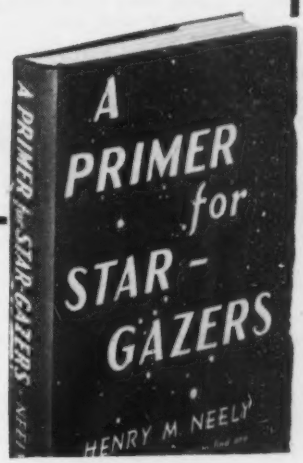

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January: STARS OF WINTER.

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P. O. Box 9866, Los Feliz Station, Los Angeles 27, Cal., Olympia 1191

SCHEDULE: Wednesday and Thursday at 8:30 p.m. Friday, Saturday, and Sunday at 3 and 8:30 p.m. Extra show on Sunday at 4:15 p.m.

STAFF: *Director,* Dinsmore Alter. *Other lecturers:* C. H. Cleminshaw, George W. Bunton.

December: OUR STAR, THE SUN. An illustrated description of the sun, sunspots, prominences, corona; effects of the sun on the earth, including an auroral display; comparison of our sun with other stars.

January: A PREVIEW OF THE 1947 SKY.

HAYDEN PLANETARIUM

81st St. and Central Park West, New York 24, N. Y., Endicott 2-8500

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.

STAFF: *Honorary Curator,* Clyde Fisher. *Chairman and Curator,* Gordon A. Atwater. *Other lecturers:* Robert R. Coles, Catharine E. Barry, Shirley I. Gale, Edward H. Preston.

December: THE WISE MEN'S STAR. Under the man-made skies time is turned back and we look among the stars of long ago for the famous star the Wise Men followed.

January: WINTER CONSTELLATIONS.

"widdershins" universe. Several verses with astronomical slants are included in a pleasant little chapter on "Poet's Numbers."

Two chapters, "Symbols" and "The Ghost Quantity," treat with breathtaking speed a number of more advanced topics including permutations and combinations, calculus (differential and integral), Taylor's theorem with the remainder, and the algebra and geometry of complex variables. All this and more occupies but 23 pages! These portions of the book seem too sketchy to be intelligible except to those already familiar with the subjects covered. In the main, however, **The World of Numbers** might easily be read by anyone who retains a smattering of high-school mathematics.

JAMES B. ROTHSCHILD

TOTAL ECLIPSE OF THE SUN

May 20, 1947

United States Nautical Almanac Office, Supt. of Documents, Washington 25, D. C., 1946. 48 pages and charts. 25 cents.

WHETHER OR NOT you are planning or thinking of planning to observe next year's very favorable eclipse, this pamphlet is worth having for study and reference. Our government astronomers have done their usual thorough job in collecting practically all the data of importance in advance of the eclipse itself. It makes fascinating reading for any amateur interested in eclipses, and perusal of its tables and charts reveals many astronomical principles associated with eclipses in general.

A large chart shows the entire area of the earth affected by the partial and total phases. The partial phases are confined to most of South America and practically all of Africa. The path of totality extends from Santiago, Chile, through Salvador (Bahia), Brazil, each of these cities lying close to the central line. The Ivory, Gold, and Slave Coasts of Africa will view totality of about four minutes' duration, while Lake Victoria lies close to the end of the shadow path. The highlands of Brazil appear to offer the best sites for observing, when both meteorological conditions and the duration of totality are considered. C. A. F.

NEW BOOKS RECEIVED

SCIENTIFIC INSTRUMENTS, Edited by *Herbert J. Cooper,* 1946, *Chemical.* 305 pages. $6.00.

Fifteen British scientists have contributed to a general discussion of all kinds of scientific instruments (British examples are used). The book has five parts: Optical Instruments; Measuring Instruments; Navigational and Surveying Instruments; Liquid Testing; Miscellaneous, including acoustics, calculating machines, hardness indicators, and vacuum tubes and thermionic valves.

PRINCIPIA, *Isaac Newton,* A Revision of Motte's Translation by *Florian Cajori,* 1946, Univ. of California Press. 680 pages. $6.50.

The only up-to-date version of Sir Isaac Newton's *Principia* available to the modern reader. First translated from the Latin by Andrew Motte in 1729, the translation has been revised and modernized and a historical and explanatory appendix supplied by the late professor of the history of mathematics of the University of California.

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SKY-GAZERS EXCHANGE

Classified advertisements are accepted for this column at 40 cents a line per insertion, six words to the line. Minimum ad is three lines. Remittance must accompany orders. Address Ad Dept., Sky and Telescope, Harvard Observatory, Cambridge 38, Mass.

WILL TRADE: Two excellent 8″ parabolic mirrors of 72″ f. l. complete with two-piece cast iron cells for one good 10″ or larger pyrex mirror. Arleigh J. Oliver, 1001 Russia Ave., San Francisco 12, Calif.

FOR SALE: M71 coated tank telescope 5x, wide angle 65° apparent field $20.00; elsewhere, $29.00. Also one astronomical achromatic rich field telescope 12x with 70 mm. objective and wide angle 70° apparent field eyepiece three achromatic lens type. Coated optics throughout. An ideal richfield, Milky Way, nebulae and comet scope of high light-gathering power. Dr. H. E. Paul, Norwich, N. Y.

FOR SALE: Practically new Zeiss 110 mm. (4.4″) refractor fitted with prism erecting device and triple revolving ocular adapter with three oculars. Sturdy portable tripod, altazimuth mount. Case for complete outfit. $800.00 for quick sale. Box HM, Sky and Telescope.

FOR SALE: 10x80 German binocular plane spotting scope. Unusually fine condition, untouched, almost new. Adjustable soft headrest-eyeshade, individual focusing eyepieces inclined 45°. Right has open center lines. Elegant night illuminator shows lines red. Quick-detach assembly with battery, case, rheostat, extra tiny bulb. 3 internal filters. Clear aperture 80 mm. F. L. about 11″, exit pupil 8 mm. Most comfortable scope we ever used. Finish dark bluish-gray with 5¼″ polished nickel lens shades. Very handsome instrument. $225.00. Lawrence Braymer, Lahaska, Pa.

FOR SALE: 10½″ brass cell, ½″ internal and external flanges. $15.00. 8½″ brass cell, ½″ internal flange. $10.00. These units will make perfect mirror cells. Shipped express C.O.D. P. Carruth, Berwyn, Md.

FOR SALE: One pair of 5½″ diam., ⅝″ thick Grade A optical glass blanks. $35.00. John Meyer, 1884 Suydam St., Ridgewood 27, L.I., N.Y.

WANTED: 1¼″ solar prism with eyepiece and filter; also equatorial mounting head with slow motions in R.A. and Dec., suitable for 4″ refractor. Send photo or sketch. H. B. Chase, 40 Hummock Road, Quincy, Mass.

FOR SALE: Combination terrestrial and astronomical refracting telescope made by E. Vion, Paris. Reconditioned. Length extended 44½″, 53 mm. objective, two eyepieces, each with sun disk, 47 and 63 power. Sun shield and cover, wood tripod. Best offer gets it. A. E. Dudley, 7 Nelson Heights, Milford, Mass.

FOR SALE: Refractor 2″, 64x, 44x, tripod, $75.00. Excellent for sun, moon, planets. J. H. Karr, 96 N. Johnson Ave., Pontiac, Mich.

FOR SALE: Webb's Atlas of the Stars containing 9th mag. stars from the north pole to 20° south. 149 pages, cloth bound. Price $4.00. H. B. Webb, 145 President St., Lynbrook, Long Island, N.Y.

CLOSING OUT: Eyepiece cases of enameled and welded steel, felt lined throughout. Each takes 6 oculars in tray with plenty of room to spare for prisms, etc. Carrying handle, trunk clasps, name plate. $2.00 each. Valley View Observatory, 106 Van Buren Ave., Pittsburgh 14, Pa.

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View of 7 x 50 Binocular

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Stock #20,000-Y ..... $2.00 Postpaid

GIANT SIZE RED AND AMBER FILTERS
Filter material is cemented between glass. All ¾" thick.

Stock No.	Color	Diam.	Price
706-Y	Red	7-7/8"	$2.00
707-Y	Red	5-7/8"	1.50
708-Y	Amber	7-7/8"	1.50
709-Y	Amber	5-7/8"	1.00

USES: For large camera filters, for large size spotlights, for darkroom lights (spectroscopically tested), for interior decorating, for display tray in home or store.

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RIGHT ANGLE PRISM—Flint Optical Glass, size 41 mm. by 91 mm. by 64 mm. Use in front of camera Lens to take pictures to right or left while pointing camera straight ahead. Also used in front of camera Lens to reverse image in direct positive work. Two of these Prisms will make an erecting system for a Telescope.
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90-45-45 deg. 5¾" long, 2⅛" wide, finely ground and polished.

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(Illustrated Book on Prisms included FREE)

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3006-Y	Porro Abbe Prism	$0.25 each
2024-Y	10 Pieces Circular A-1 Plate Glass (Diam. 31 mm—for making Filter)	.25
3021-Y	Amici Roof Prism (3rd Grade)	.25 each
523-Y	Six Threaded Metal Reticle Cells	.25
624-Y	Neutral Ray Filter size 4¾" x 2½"	.25
3022-Y	Round Wedge 65 mm. diam. ..	5.00 each
16-Y	Level Vial, 48 mm. long	.20 each
1040-Y	6 Power Magnifier—diam. 25 mm.	.25 each
2036-Y	Standard Crossline Reticle — diam. 29 mm.	.50 each
1034-Y	Burning Glass Lens'	.25 each
535-Y	Small First Surface Mirror ..	.30
3003-Y	Amici Roof Prism with Corrected Roof	2.50
633-Y	2 Combination Polarizing and Infra-Red Filters, diam. 20 mm.	.50

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6168-Y	29	76	1.25
6171-Y	32	171	1.00
6173-Y*	34	65	1.00
6176-Y*	38	131	1.00
6177-Y*	39	63	1.10
6178-Y*	45	189	1.50
6179-Y*	46	78	1.25
6182-Y	27	51	1.25
6183-Y	44	189	2.50

*ASTERISKED ITEMS are uncemented, but FREE cement and Directions included with uncemented sets.

USES:—Use these Lenses for making Projecting Lenses, Low Power Microscope Objectives, corrected Magnifiers, substitute enlarging Lenses, Eye-Piece Lenses, Macro-photography, Gadgets, Optical Instruments, etc., etc.

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Can be used as Slide Viewer, or take it apart and you can get Polarizing Variable Density Attachment, Mangin Concave Mirror, Reflector Plate, Metal Reticle, Window, Lamp Housing, Ring and Bead Sight. The Polarizing attachment alone is worth many times the price of entire unit. Consists of 2 Polarizing Filters mounted with small handle which rotates one around the other. May be used in Photography, Research, Experiments, as Light Dimmer, etc.
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3053-Y	Right Angle	70 mms.	168 mms.	3.00
3001-Y	Lens Surface	20 mms.	14 mms.	2.00
3006-Y	Porro-Abbe	9 mms.	9 mms.	.25
3009-Y	Porro	52 mms.	25 mms.	1.00
3029-Y	Dove	16 mms.	65 mms.	1.25
3036-Y	80 Degree Roof	60 mms.	36 mms.	4.00
3038-Y	Roof Prism	18 mms.	34 mms.	2.50

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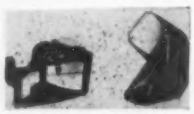
Achromatic Telescope Objectives

3-inch (76.2mm.) diameter, 15-inch (381mm.) effective focal length (f5). Front and back surfaces Magnesium Fluoride coated, cemented, optically centered and mounted in aluminum cell, 3⅝″ O. D.; clear aperture 2-15/16″. Designed for telescope work. Price $22.50.

PRISM



Best optical quality. Precision ground to "astronomical" tolerances. Either for telescope diagonal or inverter. A small prism cemented to larger one. Small size: 1 9/16″ x 1 9/16″, large: 1 9/16″ x 2¼″ face. Fluoride coated. In mount—$12.00.

DOVE (INVERTING) PRISM

A) 3″ long, face 11/16″ square.
B. S. Crown 1.517 ..... $1.00 ea.
B) 1-15/16″ long, face 7/16″ square.
B. S. Crown 1.517 ..... 50c ea.

Unpolished Tank Prism 2″x2″x6″

Crown glass, over 1 lb. Paper w'ght, name plate, novelty in den or office. 20c in our store. 50c postpaid.

Diagonal For Reflecting Telescope

Prism in metal spider mount to fit 5-6-7-8″ tube. Light flint glass, fluoride coated, 1¼″ x 1¼″ face. Arms present thin edges to light path. Easily adjusted to slight differences of tube diameter for prism centering by screws and lock washers. Complete—$7.00. Specify tube size.

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Roof prism inverter App. 8 pwr. 32 mm. objective mount has graduated scales and reticle. In case $30.

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GLEANINGS FOR A. T. M.s

Two Reflectors Built During the War

SPACE REQUIREMENTS have made it necessary to delay publication of two worthy items held in our mailbag since before the end of the war. Presumably, the wooden telescope idea is no longer of real practical value for the future, but it is well worthy of note as a historical item. The 12-inch reflector is by no means perfect, but shows what an ATM's ingenuity can do in spite of handicaps.

An All-wooden Reflector. This "ersatz" instrument was designed and constructed by Richard S. Luce, now chairman of the Optical Division of the Amateur Astronomers Association in New York City. Even though it has an equatorial mounting, it is constructed entirely of wood, except for bolts and screws (and optical parts). It is a 6-inch Newtonian, complete with friction clamps on both axes, latitude adjustment, and folding tripod.

The wood in nearly all parts is laminated, which provides for sturdier and more durable construction. Even the shafts of the mounting are of wood, well seasoned, and carefully turned and polished. Use has demonstrated that wooden axes are not satisfactory, but the remainder of the telescope leaves little to be desired in serviceability. Setting circles are included.

Because of its surprisingly light weight, amateurs who desire a really portable telescope may be attracted to this design. Mr. Luce states that he intends to move the entire mounting farther back on the tripod to obtain a more equal distribution of weight.

A 6-inch portable Newtonian equatorial made of wood, constructed by Richard S. Luce, of the Amateur Astronomers Association of New York.

GLEANINGS is always ready to receive reports and pictures of amateur instruments and devices, and is open for comments, contributions, and questions from its readers.

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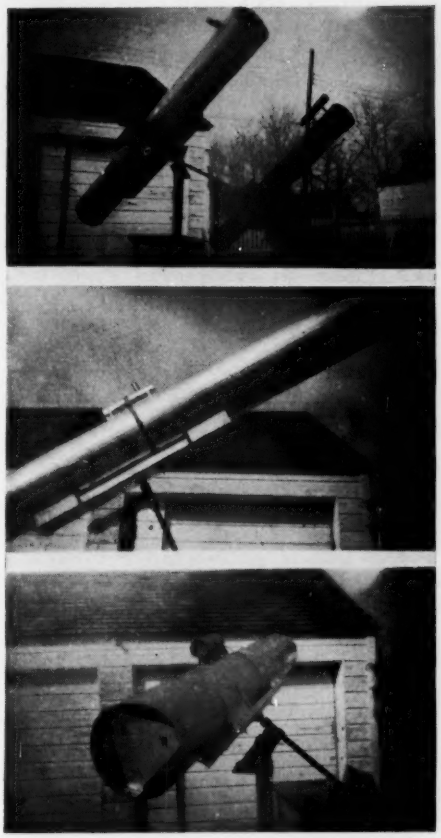
EDITED BY EARLE B. BROWN



A 12-inch f/9 Reflector. An instrument costing not in excess of $50.00 and requiring about a year's work has been built by Russell W. Hall, Jr., of 2034 Banks St., Houston, Tex.

The mirror is a piece of commercial plate glass 1¼ inches thick, which our amateur points out has shown surprisingly good performance although it is rather thin for its diameter. He writes:

"Flexure is noticeable when observing near the horizon, but I believe this can be cured by increasing the number of edge supports. The figure is only 70 per cent edge-corrected, and there is a hole in the center about 1½ inches in diameter, the only apparent effect of which is upon my conscience. It is the consensus among amateurs here (Houston, Tex.) that an undercorrected mirror works more satisfactorily than a fully corrected one, especially when it is constructed out of plate glass.

"The mounting is of the German type, semiportable. A base I-frame of 2 x 8 wood rolls on four large ball-bearing casters, and carries an upright support consisting of 4½ feet of three-inch heavy

At left are shown Mr. Hall's telescopes.

Top: The 12-inch in the foreground and a 6-inch reflector in the background.

Middle: Note the long saddle which stiffens the tube of the larger instrument.

Bottom: Showing the cell and adjusting screws for collimating the mirror.

PYREX 4¼-INCH REFLECTOR
Equatorial mount on tripod $98.00
3-inch REFRACTOR, equatorial mount, with slow motion $265.00
EQUATORIAL MOUNT constructed from brass and aluminum $59.00
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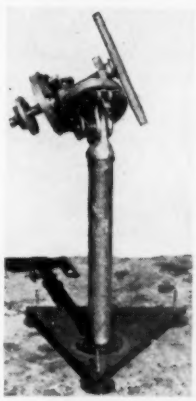
KELLNER EYEPIECES 1" f.l., wide field, minimum transverse color aberration $10.00
RAMSDEN EYEPIECES 1" f.l., designed to be free of color and distortion errors $5.50
SKYSCOPE EYEPIECES $\frac{1}{8}$" diam., ¼" Ramsden, 150 power $5.00
Objectives, Parabolic Mirrors, Prisms and Flats in stock, made by expert opticians. Our plant is equipped for production and experimental work.
ACHROMATIC MAGNIFIERS 6½ power, in brass mount $3.00
POLAROIDS 18-mm. dia., in mount, pr. $2.00
SHADE GLASSES 4 contrasts, 13-mm. diam., turret mounted $1.50; unmounted $1.00
We invite you to make use of our laboratory testing facilities, and to receive an accurate report on your mirrors, objectives, etc.
L & M Optical Co.
69 S. Lexington Ave., White Plains, N. Y.

HAINES UNIVERSAL TELESCOPE MOUNTING



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For 12-inch mirrors and larger, fork-type mountings, cut from 2½" armor plate, are recommended. Fork for 12-inch size weighs 150 lbs. and will carry 1,000-lb. telescope. Polar-axis ball bearings will carry 5 tons. Fork for 16-inch mirrors weighs 190 lbs.; for 20-inch mirrors it weighs 220 lbs.; for 24-inch mirrors, 275 lbs. Telescope tube and other parts also supplied ready for insertion of optical elements. Write for prices.

SPECIAL: Revolving Observatory Domes of Structural Steel, 12-foot diameter, shipped in parts so the amateur can assemble with a wrench according to instructions; he can have covered by local tinsmith or do cover himself. Complete instructions for observatory building free. Dome **$750.00** f.o.b. Englewood.

MOUNTING SPECIFICATIONS:

1. 50 lbs. of aluminum used in manufacture.
2. Will carry a telescope weighing 100 lbs.
3. Baseplate of 1-inch steel, weight 160 lbs.
4. Telescope quickly attached and removed.
5. Circles 13 inches in diameter, with very accurate divisions made from master index plate used for Navy sextant models, with arcs accurate to 5 seconds of arc.
6. Declination circle is solid disk of aluminum, with divisions every 30 minutes of arc.
7. Right-ascension circle is thick aluminum ring with divisions each 2 minutes of time.
8. Equipped to take any kind of drive accessory.
9. Timken roller bearings on polar axis spindle.
10. Powerful brake system for locking polar axis.
11. Softer brake on declination axis.
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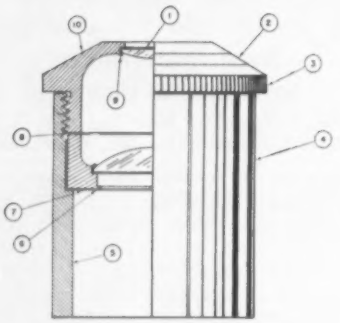

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duty pipe, which forms the pedestal. The polar axis runs in two plain bearings, 10 inches apart for solidity; these are carried by a rectangular steel plate set at the latitude angle. The polar axis is one-inch shafting. The declination axis is of shafting 1 3/16 inches in diameter, riding in a reinforced one-inch pipe tee. An 8 x 16 plate attaches to the tube saddle.

"The tube is 20-gauge galvanized iron, not as heavy as I would have liked, but all that was available at the time. The saddle is four feet long, and built up around a piece of 2 x 10 lumber. This design adds sufficient stiffness to the tube to make it quite solid.

"The finder is a 3-inch rich field, f/3.3. In many ways the view through the finder is more thrilling than that through the main telescope.

"The portable mounting leaves something to be desired in the way of rigidity, as a 12-inch is really a little too large for portability, at least when its focal length is 108 inches. I hope to place it in an observatory at some future date."

A CHRISTMAS FANTASY

(Continued from page 7)

But especially fitting this year is a suggestion that the object the Wise Men followed may have been something we have all seen and admired on many occasions—a brilliant morning or evening star. Anyone who has observed Venus glowing in the twilight above the southwestern horizon this autumn should appreciate the appropriateness of this theory. It is to be presumed, of course, that the Magi were familiar with the planets as morning and evening stars. But at the same time we must remember that on this occasion they were searching for a suitable sign in the sky. And an object of such brilliance as Venus might well have been interpreted as that sign.

Therefore, let us choose the planet Venus as the object most fitting to adorn the summit of our Christmas tree. Glowing there in all its radiant beauty it stands as an appropriate symbol of that first Christmas star.

And in the real sky this bright planet, rising in the southeast before the sun on Christmas morning, will shine this year as a Christmas star for all the world — a symbol of the spirit of "Peace on earth to men of good will."

The INDEX for Volume V

is now in preparation. Its style is similar to previous indexes, including title page; author, title, subject, and topic references. Send 35 cents in stamps or coin, or include it with your subscription renewal check or money order. Your copy of the index will be mailed as soon as it is printed.

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FROM ONE ATM TO ALL THE OTHERS

(Continued from page 13)

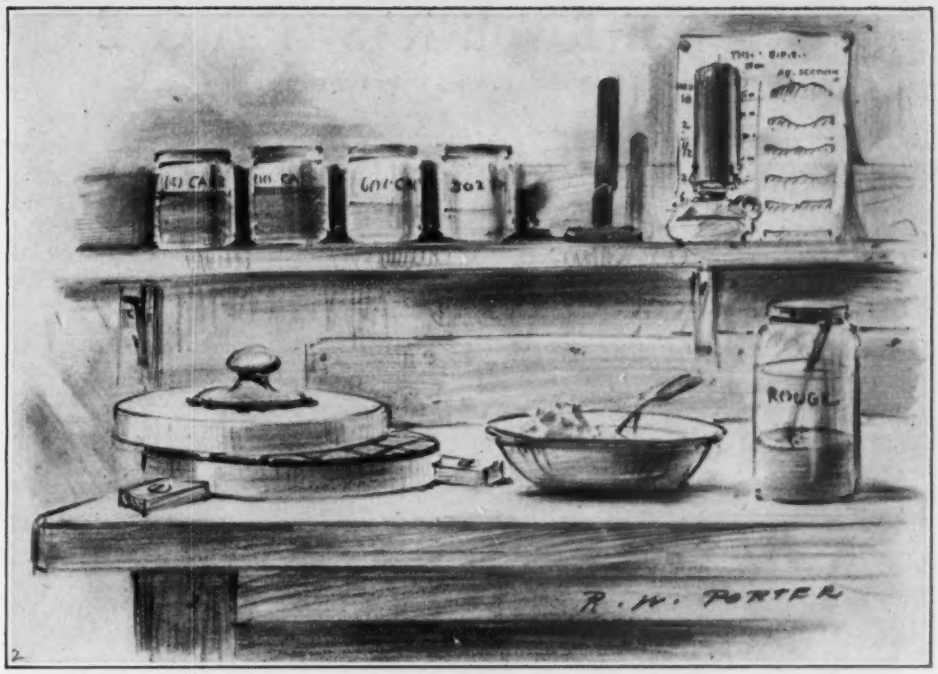
It was about this time that I came into contact with Albert Ingalls of the *Scientific American.* He was having trouble with his mirror and yelling for help. It was a fortunate thing for our fraternity that brought us together, and it was not long before the first thin edition of *ATM* was published. The gang is far more indebted to Ingalls' efforts to popularize this hobby than to any contributions made by me. I think my pencil sketches did more to clarify telescope making than anything I have written on the subject.

About this time I made some drawings of a garden telescope which Governor Hartness happened to see. The result was that a large machine tool plant was put into the business of telescope making. It was short-lived; about a hundred instruments were sold, which evidently saturated the market. Although half a dozen were sold here in southern California, I have been unable to locate them. There is one survivor. It is at Stellafane. Yes, Wilbur Perry was broken in and he made all the mirrors. The prisms and oculars came from John Brashear. Perry is now well established at Johns Hopkins University at Baltimore, and has complete charge of the Rowland grating machine.

It was 1928 when two Mount Wilson astronomers showed up at Springfield looking for me (for further details read David O. Woodbury's *The Glass Giant of Palomar*). The report they took back to George Ellery Hale evidently was a favorable one for Hale wired me to pack up and come to Pasadena, and to assist in building the 200-inch telescope. This was 18 years ago, and we are still here, and hope to die here. I've been fed up on cold weather.

I had relatively little to do with the designing of the large instrument. No *one* person designed it. It was the product of the best engineering talent, not only here but in Europe. I designed several auxiliary telescopes, many relating to the site investigation as to the best location for the observatory. But my monument probably will be the series of twenty-odd 30x40-inch cutaway drawings of various parts of the telescope and observatory. They are framed and line the walls of a long corridor in the laboratory here on the campus. This building, the astrophysics laboratory of California Institute of Technology, is the home and headquarters of both Caltech and Mount Wilson. Full-size duplicates have been framed as a result of the increasing demands for having the originals exhibited elsewhere.

I am long past the retiring age and there is little left for me to do on the project. But I still retain my office and putter around. It has been the mecca of many transient mirror victims, a surprising number of Army and Navy fellows who have been bitten by the mirror microbe and who seem to like to drop in and talk shop for a while.



An early Porter sketch of a typical telescope maker's workbench. Note particularly the old lamp fixed up for the Foucault test and the sketches of surface curves behind it.

The war, of course, put a stop to any work on the 200-inch. Naturally, I looked forward to an indefinite holiday. But no, war work took four years of intensive labor at high pressure, where my pencil and facility to draw things in three dimensions evidently were found to be useful.

And now you ask about my arctic travels. Yes, while at Massachusetts Institute of Technology I heard Peary giving an account of the first crossing of Greenland. It so inoculated me with the virus of what I call "arctic fever" that it took no less than 10 voyages above the Arctic Circle before I was ready to quit. I was shipwrecked three times, and spent three long arctic nights, when the sun is gone for 140 days.

My work was mostly astronomical and surveying. I have cleared up several thousands of miles of blank places on the maps. The first trip was to Greenland in 1894 with our dear friend, Dr. Cook of North Pole fame (or infamy). Several trips with Peary, and the last two as a member of the Ziegler polar expeditions from 1901 to 1905. The last one was a Jonah — ship crushed in the ice, starvation rations, and, worst of all, mutiny. I could go on for pages, but I've got to stop somewhere.

Yes, there is now a "second generation" of telescope makers. God bless and protect them. As I look back over the past 30 years, nothing gives me more satisfaction than realizing that I have helped towards giving thousands of people the pleasure of creating with their own hands a tool to unlock the wonders of the heavens. It has been rightly called a perfect "indoor sport." There is no kickback anywhere. It has helped as a sort of "come-on" to intrigue one in trying to understand, and conceive, the mechanism of our solar system and the universe beyond.

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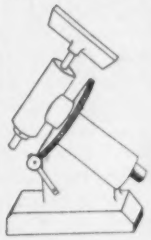

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OBSERVER'S PAGE

Greenwich civil time is used unless otherwise noted.

Planets and Occultations of Special Interest

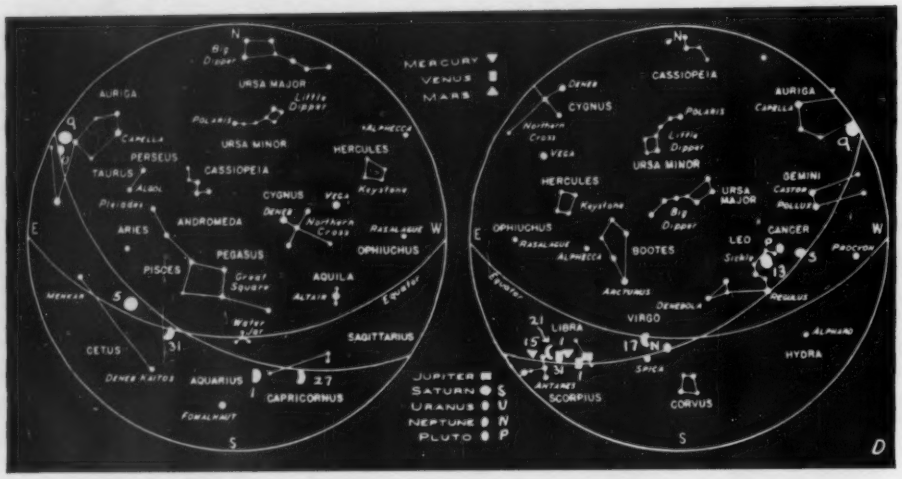
EARLY MORNING RISERS will enjoy the configurations of the planets throughout December. After Mercury rises, four bright planets are visible across the sky, their apparent positions from the sun in the same order as their actual distances. On the 1st, Mercury, Venus, and Jupiter form a triangle about six degrees on its longest side. Thereafter Mercury moves eastward, but Venus and Jupiter become closer for the first half of the month.

Meanwhile, Saturn, rising early in the evening, is favorably placed for observation all night, and in the western sky at sunrise. At that time, Uranus, Neptune, and Pluto are above the horizon as well.

No one can rightly call Mercury "elusive" this month, for the opportunity to observe it is very favorable. Its proximity to Venus and Jupiter early in the month should enable an observer to find it then and to follow it until January.

Long nights favor occultations which are visible all over the United States, and this month's program is further highlighted by occultations of Uranus, Epsilon Geminorum, and the four other stars of 4th magnitude or brighter listed here. Unfortunately, the moon is full when Uranus is occulted for observers in the East, and just past full when Epsilon Geminorum is occulted; this latter event is scheduled for all eight American standard stations. The star is so bright it should be possible to follow it telescopically right up to immersion on the bright limb of the moon, then to watch for its emersion from the just-darkening limb. Conditions are somewhat more favorable for the succeeding bright-star occultations.

THE MOON AND PLANETS IN THE EVENING AND MORNING SKIES



In mid-northern latitudes, the sky appears as at the right at 7:30 a.m. local time on the 7th of the month, and at 6:30 a.m. on the 23rd. At the left is the sky for 5:30 p.m. on the 7th and 4:30 p.m. on the 23rd. The moon is shown for certain dates by symbols which give roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

Mercury is in a very fine position for observation this month, rising 1¾ hours ahead of the sun on the 9th, when it reaches greatest western elongation, 20° 52′, at magnitude −0.2. It is then in Libra, at 15ʰ 37ᵐ, −16° 59′, well above the southeastern horizon at sunrise. During the last of November Mercury is near Venus; on December 1st their positions are 15ʰ 18ᵐ, −15° 34′ for Mercury, 15ʰ 03ᵐ, −17° 17′ for Venus. Thereafter they diverge as Mercury moves rapidly eastward. On the 15th, at 16ʰ 03ᵐ, −19° 00′, Mercury is just north of Beta Scorpii, and on the 21st, at 16ʰ 37ᵐ, −21° 08′, it still rises 1.3 hours ahead of the sun at latitude 40° north.

Venus attains greatest brilliancy, −4.4, on December 23rd. This is the planet's maximum possible brightness, which can be reached only in late December, for the planet is then at perihelion. This situation occurs once in eight years. Observers in the Southern Hemisphere will be specially favored for seeing both Venus and Mercury at this time. Venus should be easily seen after sunrise late in the month. It is stationary in right ascension on the 6th, and Jupiter is very close to it to the west.

Earth will reach heliocentric longitude 90° on the 22nd of December at 10:54 GCT. Winter commences in the Northern Hemisphere and summer in the Southern.

The moon will be totally eclipsed on December 8th, but observers in the Pacific and the Eastern Hemisphere only will view it, for central eclipse takes place at 11:48 a.m. CST. The magnitude of the eclipse will be 1.17 and the total phase will last one hour.

Mars is close to the sun.

Jupiter rises just before Venus in the morning sky and is faint by comparison, although its magnitude is −1.3. By the 31st, Jupiter rises four hours before sunrise.

Saturn may also be seen in the morning sky, although it rises about three hours after sunset, in central Cancer, of magnitude +0.2. It is retrograding as it approaches opposition in January. This is the only year for 29 years that Saturn is not at opposition, and there will not be another such year for an equal period in the future.

Uranus comes to opposition on December 12th, and is an easy object for opera glasses. Its magnitude is 5.8; it is in eastern Taurus not far from Beta and Zeta Tauri. The position at opposition is 5ʰ 16ᵐ, +23° 08′ (1946).

Neptune remains near Gamma Virginis, rising after midnight. E. O.

NEW COMET BESTER

Harvard Announcement Card 778 reports the discovery of a comet of magnitude 10.5 by J. M. Bester, of Bloemfontein, South Africa. On November 1st, at 20ʰ GCT, the comet was at 5ʰ 1ᵐ, −38° 47′, on the borderline between Columba and Caelum. Its daily motion was given as 3ᵐ west, 5′ south. Early in October this same observer found Comet Tempel II, making its regular return to the sun, although it was missed in 1935 and 1941.

The next Harvard card, No. 779, gives positions of Comet Bester obtained by Dr. G. Van Biesbroeck, of Yerkes Observatory. On November 5.3, the comet was at 4ʰ 49ᵐ.5, −38° 43′.0. It was of the 11th magnitude, diffuse with central condensation. Evidently, it was no longer moving southward.

SATURN NEAR BEEHIVE

Frank Trathen, of Napa, Cal., points out that Saturn will be near the Beehive in Cancer for the rest of the year.

GEMINID METEORS

The maximum of the annual Geminid meteor shower is scheduled for about the 12th of the month, but these meteors may be seen several days before and after that date. Their radiant point is in Gemini.

VARIABLE STAR MAXIMA

December 7, S Gruis, 7.8, 221948; 9, R Ophiuchi, 7.6, 170215; 27, R Cygni, 7.3, 193449.

These predictions of variable star maxima are made by Leon Campbell, recorder of the AAVSO, Harvard College Observatory, Cambridge 38, Mass. Serious-minded observers interested in making regular telescopic observations of variable stars may write to Mr. Campbell for further information.

Only stars are included here whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

OCCULTATIONS FOR DECEMBER

For selected occultations (visible at three or more stations in the U. S. and Canada under fairly favorable conditions), these predictions give: evening-morning date, star name, magnitude, right ascension in hours and minutes and declination in degrees and minutes, moon's age in days, limiting parallels of latitude, immersion or emersion; standard station designation, GCT, a and b quantities in minutes, position angle; the same data for each standard station westward.

Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5	**E** +91°.0, +40°.0
B +73°.6, +45°.6	**F** +98°.0, +30°.0
C +77°.1, +38°.9	**G** +114°.0, +50°.9
D +79°.4, +43°.7	**H** +120°.0, +36°.0
I +123°.1, +49°.5	

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude respectively, enabling computation of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Greenwich civil time to your own standard time.

For additional occultations consult the American Ephemeris and Nautical Almanac and the British Nautical Almanac, from which these predictions are taken. Texas predictions were computed by E. W. Woolard and Paul Herget.

5-6 **Xi Arietis** 5.5, 2:21.9 +10-22.0, 12, +77° −10° Im: **A** 2:47.2 −1.9 +0.2 78°; **B** 2:46.8 −1.6 +0.5 68°; **C** 2:37.3 −2.1 +0.3 82°; **D** 2:36.1 −1.6 +0.9 65°; **E** 2:14.4 −1.3 +1.5 55°; **F** 1:48.9 −1.5 +1.5 65°; **H** 1:45.8 0.0 +2.6 16°.

8-9 **URANUS** 5.9, 5:16.1 +23-08.8, 15, +90° +11° Im: **A** 22:28.2 +0.4 +1.5 55°; **C** 22:25.0 +0.5 +1.4 57°. Em: **A** 23:15.9 −0.1 +1.1 273°; **C** 23:11.9 0.0 +1.0 271°; **E** 23:14.0 −0.2 −0.7 288°.

9-10 **Epsilon Geminorum** 3.2, 6:40.6 +25-11.2, 16, +66° +4° Im: **A** 5:44.1 −1.8 −0.4 106°; **B** 5:41.5 −1.7 +0.1 95°; **C** 5:37.3 −2.1 −0.9 118°; **D** 5:31.4 −1.7 +0.2 98°; **E** 5:11.2 −1.6 +0.4 102°; **F** 5:00.5 −2.2 −1.2 131°; **G** 5:08.6 −0.2 +2.4 45°; **H** 4:39.3 −0.3 +1.3 77°; **I** 5:05.3 +0.2 +2.6 37°. Em: **A** 6:57.6 −1.8 +0.4 253°; **B** 6:56.2 −1.7 0.0 263°; **C** 6:45.5 −2.0 +1.4 238°; **D** 6:45.7 −1.8 +0.6 256°; **E** 6:21.7 −1.6 +1.4 247°; **F** 5:48.1 −0.8 +3.6 212°; **G** 5:58.0 −1.2 +0.2 301°; **H** 5:40.3 −0.8 +1.2 264°; **I** 5:47.4 −1.2 +0.1 308°.

10-11 **Kappa Geminorum** 3.7, 7:41.2 +24-31.7, 17, +69° +2° Im: **A** 2:36.7 −0.5 +1.2 92°; **B** 2:40.1 −0.4 +1.5 83°; **C** 2:30.7 −0.4 +1.0 97°; **D** 2:35.6 −0.2 +1.4 82°; **E** 2:30.0 +0.1 +1.4 77°; **F** 2:20.6 +0.2 +0.7 95°. Em: **A** 3:39.9 −0.9 +1.3 266°; **B** 3:42.2 −0.9 +1.0 276°; **C** 3:31.3 −0.7 +1.4 260°; **D** 3:35.5 −0.8 +1.1 276°; **E** 3:24.8 −0.4 +1.0 278°; **F** 3:12.9 0.0 +1.1 259°.

12-13 **Eta Leonis** 3.6, 10:04.4 +17-01.6, 19, +59° −19° Im: **F** 13:28.5 −2.4 −0.2 77°; **H** 12:33.8 −2.2 −0.6 103°; **I** 12:35.6 ... ... 54°. Em: **F** 14:19.8 +0.1 −3.1 346°; **H** 13:51.4 −1.2 −2.2 318°; **I** 13:10.9 ... ... 359°.

14-15 **Nu Virginis** 4.2, 11:43.1 +6-49.9, 21, +90° −4° Im: **A** 11:08.0 −1.4 −1.5 133°; **B** 11:02.3 −1.4 −1.2 128°; **C** 11:08.5 −1.1 −2.1 150°; **D** 10:57.1 −1.2 −1.5 141°; **E** 10:54.6 −0.4 −3.2 174°; **G** 10:17.0 −0.6 −1.0 156°; **I** 10:14.1 −0.5 −1.7 167°. Em: **A** 12:26.8 −1.5 −1.5 299°; **C** 12:23.5 −2.0 −1.0 284°; **E** 11:48.8 −3.0 +1.0 257°; **G** 11:14.0 −1.4 +1.6 263°; **I** 10:58.6 −1.3 +2.8 248°.

28-29 **Tau Aquarii** 4.2, 22:46.7 −13-52.7, 5, +66° −15° Im: **F** 3:21.3 ... ... 133°; **G** 2:45.6 −0.4 +0.4 30°; **H** 2:37.5 −1.3 +0.1 61°; **I** 2:41.7 −0.3 +0.9 20°.

GREENWICH CIVIL TIME (GCT)

TIMES used on the Observer's Page are Greenwich civil or universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the GCT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

PHASES OF THE MOON

First quarter	December	1, 21:47
Full moon	December	8, 17:52
Last quarter	December	15, 10:57
New moon	December	23, 13:06
First quarter	December	31, 12:23
Full moon	January	7, 4:47

MINIMA OF ALGOL

December 1, 23:31; 4, 20:20; 7, 17:09; 10, 13:58; 13, 10:47; 16, 7:37; 19, 4:26; 22, 1:15; 24, 22:04; 27, 18:53; 30, 15:42.

CORRECTION TO ALGOL MINIMA

The minimum of Algol predicted in the October issue for October 18th, at 2:29, should have been one day earlier, at the same time on the 17th. All the succeeding predictions were similarly in error, for October and November, by one day. We regret this mistake, and thank Olin J. Eggen, of Washburn Observatory, for calling it to our attention.

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LOW POWER FINDER with CROSSHAIRS
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RACK AND PINION FOCUSING
5 FT. HARD MAPLE TRIPOD
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The unusual richness and brilliance of objects seen with this telescope is largely due to its expertly ground objective lens of first quality crown and flint optical glass—corrected for chromatic and spherical aberrations. Even the beginner can distinguish over 300 objects on the moon—the planet Uranus—polar markings on Mars—belts of Jupiter—Saturn, its rings and some satellites. Additional information sent on request.
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2526 GROVE ST.
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EVENING STARS FOR SOUTHERN OBSERVERS

THIS CHART is prepared for a basic latitude of 30° south, but it may be used conveniently by observers 20 degrees on either side of that parallel. These southern charts appear in alternate months, but always two or three months in advance, to allow time for transmission to observers in any part of the world. The sky is here shown as it appears on Feb. 7th at 11 p.m., Feb. 23rd at 10 p.m., March 7th and 23rd at 9 p.m. and 8 p.m., respectively. Times for other days vary similarly, four minutes earlier per day. These are local mean times which must be corrected for standard time differences. The 30° horizon is a solid circle; the other horizons are circles, too, those for 20° and 40° south being dashed in part. When facing south, hold "South" at the bottom, and similarly for other directions. Observers in the tropics may find north circumpolar stars on any of our northern star charts. For other charts in this series, see issues of alternate months, February, 1945, to June, 1945; September, 1945, to July, 1946; and August, 1946, to the present.

North
50° HORIZON
40° HORIZON
30° HORIZON
BOOTES
CANES VENATICI
LEO MINOR
URSA MAJOR
LEO
DRACO
URSA MINOR
HERCULES
KEYSTONE
LYRA
CYGNUS
CEPHEUS
CASSIOPEIA
PERSEUS
AURIGA
GEMINI
CANCER
ECLIPTIC
CANIS MINOR
ORION
MONOCEROS
CANIS MAJOR
LEPUS
ERIDANUS
TAURUS
PLEIADES
HYADES
ARIES
TRIANGULUM
ANDROMEDA
GREAT SQUARE
PEGASUS
PISCES
CIRCLET
WATER JAR
EQUULEUS
DELPHINUS
SAGITTA
AQUILA
EQUATOR
VERNAL EQUINOX
ECLIPTIC
CETUS
AQUARIUS
CAPRICORNUS
PISCIS AUSTRINUS
SCULPTOR
FORNAX
COLUMBA
CAELUM
PHOENIX
GRUS
HOROLOGIUM
MERIDIAN
40° HORIZON
50° HORIZON
30° HORIZON
South
East
West
Rigel
Procyon
Betelgeux
Aldebaran
Capella
Castor
Pollux
Alhena
Sirius
Adhara
Wezen
Mirzam
Phact
Rigil
Menkar
Al Rischa
Mira
Hamal
Algenib
Alpheratz
Schedir
Mirach
Andromeda
Merak
Dubhe
Alkaid
Mizar
Alcor
Polaris
North Pole
Little Dipper
Big Dipper
Thuban
Eltanin
Rastaban
Vega
Deneb
Altair
Enif
Markab
Fomalhaut
Deneb Kaitos
Achernar
Acamar
Phact
Alpha Crucis
Gacrux
Hadar
Rigil Kentaurus
Toliman
Alpha Centauri
Beta Centauri
Spica
Arcturus
Alphard
Regulus
Denebola
Algieba
Alkaid
Mizar
Alcor
Polaris
Dubhe
Merak
Phecda
Megrez
Alioth
Mizar
Alcor
Kochab
Pherkad